TECHNOLOGIES TO MAINTAIN BIOLOGICAL DIVERSITY

Volume II--Contract Papers

Part F: Grassroots Conservation Activities

1. Role of Grassroots Activities in the Maintenance of Biological Diversity: Living Plants Collection of North American Genetic Resources
(Gary Nabhan and Kevin Dahl)

2. Report on Grass Roots Genetic Conservation Efforts
(Cary Fowler)

3. An Assessment of the Conservation of Animal Genetic Diversity at the Grassroot Level
(Elizabeth Henson)

4. Grassroots Groups Concerned with In-Situ Preservation of Biological Diversity in the U.S.
(Elliott A. Norse)

December 1986

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TABLE OF CONTENTS

Page

1. Role of Grassroots Activities in the Maintenance of Biological Diversity: Living Plants Collection of North American Genetic Resources
(Gary Nabhan and Kevin Dahl) .....

2. Report on Grass Roots Genetic Conservation Efforts
(Cary Fowler) .....

3. An Assessment of the Conservation of Animai Genetic Diversity at the Grassroot Level
(Elizabeth Henson) .....

4. Grassroots Groups Concerned with In-Situ Preservation of Biological Diversity in the U.S.
(Elliott A. Norse) .....

Contract Paper No. 1

Role of Grassroots Activities in the Maintenance of Biological Diversity: Living Plants Collection of North American Genetic Resources

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Native Seeds Search

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ROLE OF GRASSROOTS ACTIVITIES IN THE MAINTENANCE OF BIOLOGICAL DIVERSITY: LIVING PLANT COLLECTIONS OF NORTH AMERICAN GENETIC RESOURCES

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TABLE OF CONTENTS

Abstract..... 1

Introduction..... 2

Objectives and Methods..... 7

Case Studies -

INDIGENOUS FARMERS
Gila River Indian Community:
In Situ Conservation of Ancient Crops..... 9

IMMIGRANT-AMERICAN FARMERS
Pete & Juanita Casados:
Hispanic-American Cottage Industries.....15

GARDENER-CURATORS
John Withee: The Extraordinary "Bean Man".....19

SPECIALTY CROP EXCHANGES
North American Fruit Explorers:
Fruit Lovers Helping Each Other.....23

REGIONAL EXCHANGES
Abundant Life Seed Foundation:
Promoting Native Northwest Plants.....26

IN SITU/EX SITU BRIDGES
Native Seed/SEARCH: Scientists Gone to the Grassroots.....29

LIVING HISTORIC FARMS
The National Colonial Farm:
Preserving Plants for Living History.....36

SUSTAINABLE AGRICULTURE EXPERIMENTS
The Land Institute:
Genetic Diversity in Ecosystem Agriculture.....38

BOTANICAL GARDENS AND ARBORETA
Desert Botanical Garden: A Scientific Showcase.....42

NATIONAL EXCHANGES
The Seed Saver's Exchange:
Sharing Genetic Resources for All to Enjoy.....46

Results.....51

Appendix A: Food Crops Native to North America
Appendix B: Contributions of Native Plant Genes to Modern Crops
Appendix C: Immigrant-American Plant Heritage Museums
Appendix D: List of North American Genetic Resources Maintained in Living Collections by the Ten Grassroots Activities Surveyed

Bibliography

ABSTRACT

In contrast to federal and state efforts at plant conservation, the grassroots activities maintaining living plant collections in the United States are experimenting with an enormous range of strategies aimed at both in situ and ex situ protection of genetic resources. Groundswells of interest in plant genetic diversity within the last two decades have initiated a variety of new organizations, and aided in the reorientation of older institutions such as botanical gardens, arboreta and agricultural museums. Many of these communities and organizations recognize the wealth of botanical resources native to the North American continent, and have explored non-formal routes of information and germplasm exchange. They currently harbor two sets of North America plant resources -- wild relatives of crops and fruit trees native to American soils, and heirloom vegetables and grains of ethnic American groups -- for which USDA gene bank collections are relatively deficient. Although most of these activities are voluntary and done by individuals not formally trained in Western empirical science, these efforts are too pervasive, sophisticated and effective to dismiss as being "unscientific." In fact, they are a needed, flexible complement to more rigid government activities.

Case studies were undertaken to examine exemplary efforts by native Americans and Immigrant American farmers, gardener-curators, seed exchangers, crop- and region-specific resource groups, historic farms and botanical gardens. The magnitude of these activities were analyzed, and the current financial, technical and policy constraints on them were elucidates. Ways to encourage the future preservation of living genetic resources through these grassroots activities are proposed.

INTRODUCTION

Grassroots activities which maintain living collections of plants are not a new phenomenon in the United States. They are an extension of a plant husbandry tradition which dates back at least 7000 years within the present-day U.S. boundaries (Conard et al., 1984) -- (see Appendix A for a resume of agricultural crops native to the U.S.). Beginning with this prehistoric American horticulture, farmers and gardeners have selected and conserved unusual variants of seedstocks, rootstocks and cuttings for their future use. Some of these are still grown today, whereas others have made their way into government plant introduction stations and have served as breeding materials for modern day crop cultivars. (See Appendix B for a list of native, wild and heirloom food plants from the U.S. that have contributed genes to modern crop production). European, African and Asian immigrants to the U.S. brought with them many additional kinds of seedstocks and cuttings, some of which are no longer found in their homelands. The descendants of these immigrants established ethnic agricultural museums, botanical gardens and other local means of preserving their cultural agricultural heritage in living collections. (See Appendix C for thumbnail sketches of outstanding Euro-American plant heritage museums.)

Until recently, such community-based activities were done without the assistance of modern (Western) empirical science. Yet it is incorrect to refer to these efforts as amateurish or unscientific. Dr. Rayna Green, a Cherokee scientist/folklorist with the Smithsonian Institution, has demonstrated that various ethnic groups each had a culture-specific version of science upon which they based practices such as seed saving and selection, or intercropping of mutualistic

plant associations. Their folk knowledge can be called science in the sense that it "attempts to explain material phenomenon... whether [it] is developed through 'experiment' or 'trial and error observation,' and whether knowledge is organized into a 'systematic body' or diffused throughout the range of cultural expression and behavior" (Green, 1981).

Such folk science has guided traditional farmers for thousands of years in encouraging and conserving genetic variation within crops, domesticating new crops from native wild species, and adapting introduced crops to new conditions. The resulting genetic diversity maintained in this manner on American farms and gardens is considerable, as the following survey results document. It is critical to remember that virtually all crop species grown on any scale within the U.S. today were first domesticated by so-called primitive farmers, not by academically-trained geneticists and biotechnologists. In the opinion of one prominent plant breeder, the use of the hardiest of these " primitive genetic resources" -- wild relatives of crops and their heirloom land races -- will be more important to future crop improvement efforts than will new bio-technologies per se (Borlaug, 1983).

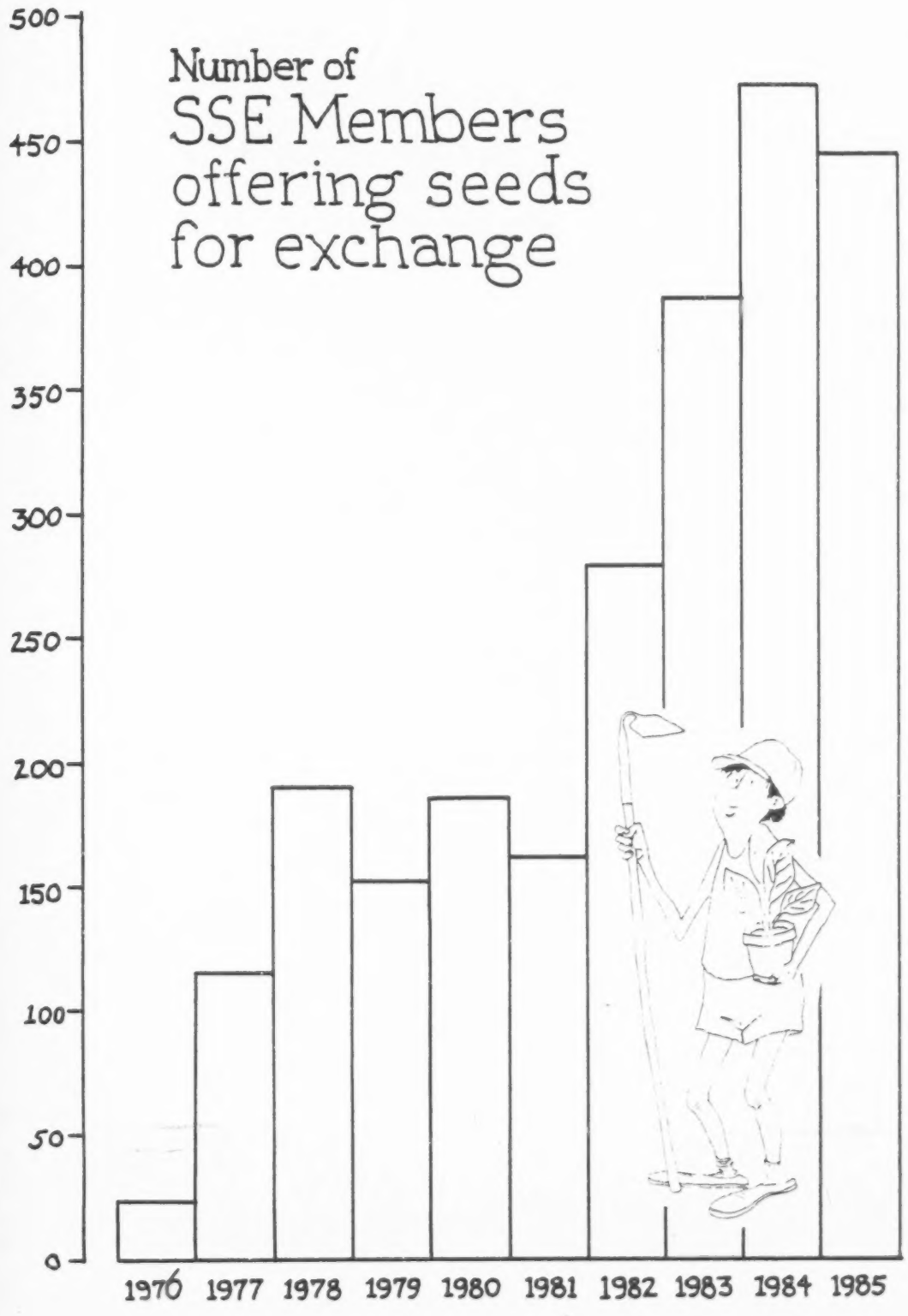
Nevertheless, because these seed saving and plant husbandry efforts are widely dispersed and particularly strong in remote rural areas, they are not as obvious as a centralized, government-managed gene bank. For this reason, their magnitude is easily underestimated, as it was in a recent survey of in situ conservation efforts in the United States prepared for the United Nations Environment Programme -- only one of the many groups documented here, Native Seeds/SEARCH, was

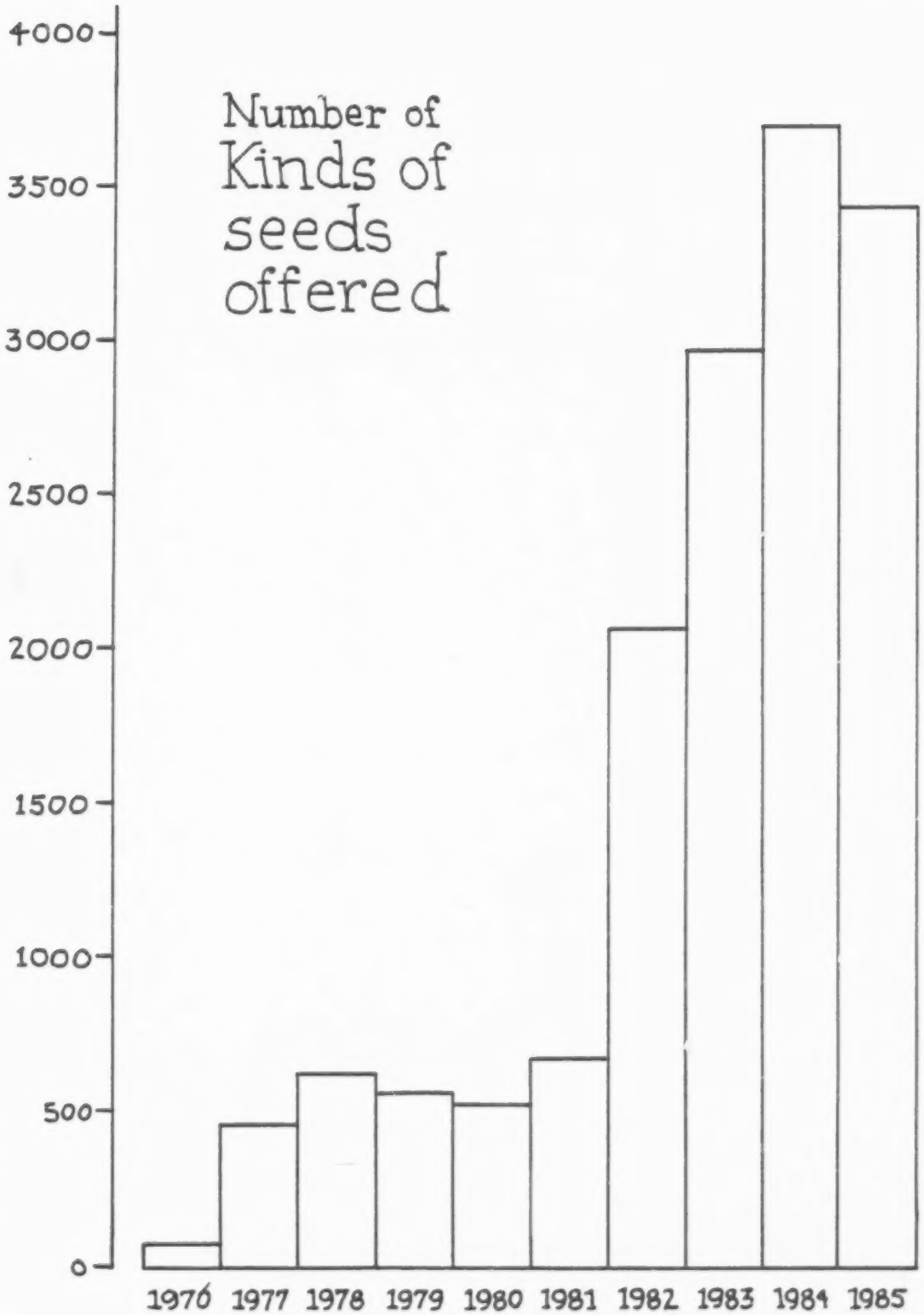
covered in that report (Long, 1985).

There are, however, advantages to how varied in scale and diffuse these grassroots activities are, for they are less vulnerable to local catastrophic weather, human-mediated disaster, or to detrimental policy change. The number of farmers and gardeners directly involved in rare plant propagation remains unknown, but the amount of people aware of such activities (and potential participants in them) is staggering. The number of visitors who see and learn of American heirloom crops and orchards at living historic farms and agricultural museums alone is on the order of a million people per year (Percy, 1981). Several of the 21 historic farms which specially grow historically-verified heirloom vegetables and fruit trees sell seed and scions of these to their visitors, thereby multiplying the number of people involved in their propagation (Percy, 1981). The North American Fruit Explorers now claims a membership of over 3000, with 45% growth rate in the last four years. The decade-old Seed Saver's Exchange has grown to include nearly five hundred members who offer over 3700 different accessions of seeds each year to one another (Whealy, 1984; see Figure 1). The rapid growth of these and other groups, and the diversity of seeds which they are harboring, suggests that seed-saving and rare tree propagation are becoming increasingly popular, more sophisticated and organized activities after undergoing a demise earlier in this century.

A significant portion of the rural population which does not become members of seed conservation organizations, botanical gardens or agricultural museums nevertheless may be involved in rare crop, tree and wild food plant propagation and use at the home level. These practitioners are sometimes of ethnic or religious groups committed to

Figure 1. The following two pages contain the draft of a graph showing the growth over the last decade of the Seed Saver's Exchange both in membership and in number of kinds of seeds offered. Source: Seed Saver's Exchange Catalogs for the years 1976 through 1985.


Number of
SSE Members
offering seeds
for exchange
500
450
400
350
300
250
200
150
100
50
0
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985


Number of
Kinds of
seeds
offered
4000
3500
3000
2500
2000
1500
1000
500
0
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985

food self-sufficiency at the family or community level, and such plants are simply a means to that end. Ethnic enclaves are not so isolated that they are not influenced by the seed trade and nursery industries, but Mormons, Mennonites, Hispanic- and Native Americans are also known to have persisted in the local exchange of seeds which are not commercially available.

For example, 19,000 Native American families cultivate dry-land or irrigated crops on a million acres of reservation lands in the U.S. Not all of these farmers grow native crops today, yet their fields and gardens remain one of the richest potential sources of genetic resources found within the U.S. boundaries (Vietmeyer, 1985). On at least one reservation of 12,000 residents in Arizona, the most frequently cultivated garden crop is a native domesticate (Proboscidea parviflora) virtually unknown to gardeners of other regions (Berry, et al., 1981); and an endangered cactus, Mammillaria thornberi, is also multiplied in these gardens. On the same reservation, approximately 131 wild plant species are conserved in native floodwater fields along with varieties of 14 domesticated crops (Nabhan, 1983c).

Although rural ethnic communities are the caretakers of many plant genetic resources that are not conserved by other means, they are also the ones most directly affected by genetic erosion or loss of a rare seedstock. These communities lament the losses of plants which had special medicinal or ceremonial uses (Nabhan, 1980). Their nutritional status may be detrimentally affected by the loss in diversity of food plants (Nabhan and Mirocha, 1985). It is therefore extremely important to identify where genetic erosion of food crops is accelerating, and to define strategies to slow or halt the forces

which drive this erosion. The following survey results document 1) the contribution to biological diversity maintenance made by community-based living collections of plants; 2) the degree of genetic erosion or plant variety loss felt in these communities; and 3) the role of technology in contributing to or reducing the plant diversity available to and managed by these groups. In order to better analyze whether specific plant resources are saved largely through the efforts of such groups, we have surveyed only their listings of land races and wild species native to the North American continent.

OBJECTIVES AND METHODS

In our survey of grassroots organizations that are growing living collections of genetically important plants we found the groups to fit into several broad catagories: Native American tribes, museums and projects; European-American family farmers; hobby gardeners; special interest groups that share an enthusiasm for one type of crop; regional seed-saving groups; living historical farms; and botanical gardens and arboreta. In addition, three emerging interest groups were surveyed: a farm promoting and practicing "sustainable agriculture"; a clearinghouse for bridging in situ and ex situ conservation of native plants; and a group whose national membership exchanges heirloom seeds. We tried to choose an example from each category that demonstrates the highest quality of genetic preservation effort currently being made within that type of group. We then place this group's efforts in relation to other, similar organizations.

Information on these efforts were compiled from recent literature, questionnaires and personal communications with the people involved. In analyzing and presenting the case studies, we tried to bring out (1) what motivates these people and organizations, and how that determines the degree to which they focus on biological diversity or germplasm conservation; (2) the number of plants each deals with; (3) the economic base and vulnerability of the operation; (4) the networking that goes on at three levels: within the group, with other similar groups, and with government- and university-sponsored conservation efforts; (5) the level of technological sophistication employed; and (6) whether the genetic conservation activities, and the source of germplasm, is expanding or contracting, and why.

From these examples we go on to extrapolate the role living

collections currently plays in conserving genetic resources in the United States, where these activities are vulnerable or failing, and what can be done to help these grassroots efforts.

INDIGENOUS FARMERS
The Gila River Indian Community:
In Situ Conservation of Ancient Crops

The Gila River Indian Community exemplifies the range of plant conservation activities in which Native Americans are currently involved. Although this reservation community is very close geographically to two of the other groups mentioned in this report -- Native Seeds/SEARCH and the Desert Botanical Gardens -- and it has had informal cooperation with both, its own involvement with plants has a very different history and rationale.

The Gila River Indian Community includes both Gila River Pima (Akimel O'odham) and a smaller population of the culturally-unrelated Maricopa tribe, collectively totalling over 6700 people (Pablo, 1983). Some of the oldest archaeological records for the presence of certain crop varieties in the United States are plant fossils found in Snaketown and other prehistoric Hohokam village ruins located on the reservation. The Pima and Maricopa had a prosperous traditional agriculture which utilized over thirty varieties of at least a dozen crop species, grown on as much as 15,000 acres of river-irrigated land at one time (Castetter and Bell, 1942; Hackenberg, 1983). Their seed-saving and plant selection practices were relatively sophisticated and have been well-documented by a team of Piman speakers, agricultural scientists and ethnobotanists (Lopez et al., 1981). Native Piman fields historically harbored a number of encouraged or tolerated wild relatives of crops which contributed to the genetic variation of the cross-compatible domesticates that were intentionally sown.

However, usurpment of river water by irrigation projects upstream, watershed destruction, and other factors led to the demise

of their agriculture between 1884 and 1935, so that in some years, no crops could be raised and tended acreage dropped to 3,000 acres for a while (Hackenberg, 1983). Although irrigated farmlands later increased to over 10,000 acres again after federal reclamation projects insured that a more stable supply of water was available to the Indians, local gene pools for jack beans, tobacco, native cotton, and several bean and corn varieties had been greatly depleted by the time World War II began. A few of these varieties were collected and studied by a USDA Plant Breeding Station on the reservation at Sacaton, which functioned into the 1950s, and the Sacaton Aboriginal cotton no longer grown by the Pima has persisted in USDA gene banks. However, other ecologically-significant varieties grown prehistorically or historically there, such as native barley, jack beans and amaranths, vanished before they were saved by any gene bank or botanical garden (Nabhan, 1985a).

Of the remaining Pima and Maricopa farmers, only a small percentage save native seeds for planting (Miller and Mittleman, 1985, Long, 1985). Knowledge of traditional seed-saving techniques does not often extend beyond the elderly (Long, 1985). Yet the few farmers who have persisted with these traditions still conserve a remarkable amount of genetic variation within particular land races of crops, and a considerable number of land races altogether. Up until recently, these farmer-conservers have done so without outside encouragement, or knowledge that their work was of interest to conservationists and agricultural scientists.

Albert Cooley is an excellent example of such a conserver, and his crop diversity has recently been featured in The Seedhead News (Nabhan, 1985b) and in a Nova science special on genetic resources to

be aired on public television on October 15, 1985. Of Pima, Apache and Irish decent, Cooley grew up working in the traditional Pima farming village of Komatke, and early-on learned techniques for growing and saving seed of native crops. After decades of professional work as a house painter in Phoenix, he returned to the reservation and gradually increased his farming activities at the homestead of his aunt, near Upper Santan on the Gila River. Of Native American domesticates, he grows Pima 60 day flour corn, Mexican June corn, two kinds of drought adapted tepary beans, mottled lima beans, bottlegourds, cushaw squash and devil's claw (Nabhan, 1985b). Of Spanish- and Anglo-introduced crops, he grows black-eyed peas, watermelons, a special ecotype of muskmelons, tomatoes, chiles, eggplants, apricots, pomegranates, and peaches.

His "garden" is less than three acres in size, but produces enough surplus than he is able to sell a number of native foodstuffs to Pima, Papago and Maricopa families, some of whom come 200 miles to obtain these rare commodities. Except for small tractors and cultivators, the farming and seed-saving technologies he uses are similar to those found among the Pima a century ago. Some of his bean crops yield on just two irrigations, far less than the amount of water used by Anglo-American farmers nearby.

Because older farmers such as Cooley often discuss the crop varieties that have been or are being lost from their tribal heritage, the Gila River Indian Community's Department of Human Resources initiated a "seed pool" program in 1982. Obtaining traditional O'odham seedstocks from the Meals for Millions (later Native Seeds/SEARCH) program, and from families which had some seeds to spare, Pima health

professional Sally Pablo distributed hundreds of seed packets to community members, asking that they grow them out and return a portion to the department office which could then be shared with additional families the next year.

In additional to these grassroots activities, the tribal government has been involved with more formal, "non-grassroots" efforts to promote and develop desert plants. The Gila Indian Center is a tribal-run heritage park and museum which offers "family fun and cultural edcation" to tourists interested in learning of the history of the desert basin of the Gila River (Long, 1985). As part of the heritage park, 18 wild desert plant species harvested by the Pima are identified by common English and O'odham names, and their uses discussed along the formal trails between exhibits. Additional, native cultivated plants are highlighted on exhibit boards.

The other formal program is a tribal corporation named the Amerind Agrotech Laboratories, directed by Cherokee William Miller, in Sacaton, Arizona. Since the 1970s, it has attempted to identify, research, develop and commercialize new, underutilized and overlooked arid and tropical zone plants which yield oil, fat, fiber, food and energy (Miller and Mittleman, 1985). It has specific cooperative agreements with three Fortune 500 companies, two foreign private corporations, two small domestic companies and seven individual new crop scientists to develop for profit a number of wild desert plants into crops (Miller and Mittleman, 1985). Up until now, they have also utilized government-sponsored loans and research grants, but "interest from both domestic and foreign investors looks promising" enough to assure them of a reliable financial base for several years even if public support for applied economic botany continues to wane.

Another financial opportunity which the lab is pursuing is the development of a rubber-bearing guayule variant which they discovered seed of on the ground of germplasm evaluation plots at Arizona Agricultural Experiment Station several years ago. This robust "Gila" line has not been improved by plant breeding per se, but by selection of progeny from this mutant. The lab has claimed legal "rights of discovery" to this quicker-growing "Gila" shrub, and hopes to gain a patent or plant variety protection for it on behalf of the Gila River Indian Community and its corporation's investors (Miller, 1985). Because infrequent discoveries such as this are made when screening a broad range of germ plasm, Director Miller sees preservation of genetic diversity as part of their goal in commercializing overlooked useful plants. They are working with 6-8 underexploited species native to North America.

Although the Amerind Agrotech Lab has cooperated with the USDA gene banks in the past, its staff is discouraged by "new policies within NSF and USDA not to support applied agronomic R&D..." and feels that "ATL will be seriously set back by this policy" (Miller and Mittleman, 1985). Miller (1985) believes that one can correctly claim that the increased emphasis in the USDA and NSF on basic biotechnology research has diverted funds which might have otherwise gone to the conservation of genetic diversity, new crop development, and applied agronomic research and development. In terms of its acceptance of new and emerging biotechnologies, the corporation has made every attempt within the capabilities of its financial base to explore the possibilities of these for engineering crop improvements. They hope to collaborate with biotechnologist Dr. Dick Radin in applying cell

culture techniques to increasing the uniformity of the selected progeny of the Gila guayule mutant (Miller, 1985).

As a secondary activity, it has begun to freely distribute tepary, devil's claw and chiltepin seeds back into the Pima and Maricopa communities, hoping to encourage continued local cultivation of these plants. Over forty acres of teparies have also been planted in response to AID interest in making this desert-adapted legume available in drought-stricken Africa.

Magnitude of Other Indigenous Farmer Efforts

The range of activities relating to native crop conservation among the Gila River Indian Community may be unique, but other reservations have also begun plant conservation programs. The Navajo Nation, which inhabits the largest Indian reservation in the U.S., has tribal zoological and botanical gardens, and a Natural Heritage program guided by The Nature Conservancy. The second largest reservation, of the Papago or Tohono O'Odham, has accomplished native crop seed distribution through its nutrition education program, and may expand that to include wild food plants (Floyd Flores, 1985). Other reservations -- including those of the Cocopah, Walapai, Havasupai, Colorado River Indian Tribes, Hopi San Juan Pueblo, Taos Pueblo, and Confederate Tribes of Warm Springs, Oregon -- have initiated modest efforts or are in planning stages.

Perhaps the unique factor that slows such efforts is the healthy skepticism with which contemporary Amerindians have met Western scientific expertise (Williams, 1985). Western concepts of botanical classification, genetics and seed physiology sometimes run counter to or appear obscure compared to native concepts. There are few Indian professional confident both in traditional science and Western science

who can bridge this communication gap (Williams, 1985), and a high turnover in non-Indian professionals working on reservations. Additionally, few Indian political leaders include native agriculture in their growing recognition that preserving native religion, language and culture is important. Sadly, the farmers who continue on with centuries-old crop genetic legacies of the their culture seldom receive encouragement from the BIA or development organizations. The negative notion that such farming is "old-fashioned", "unsophisticated" or "inefficient" still serves as a disincentive for its continuity.

IMMIGRANT-AMERICAN FARMERS
Pete and Juanita Casados:
Hispanic-American Cottage Industries

Pete and Juanita Casados conserve and promote heirloom vegetables and grains that are important ingredients in the regional, ethnic foods of the Rio Grande valleys of New Mexico and southern Colorado. Based on a 150-acre irrigated farm on the Rio Grande floodplain, they raise local specialties such as native blue flour corn, native New Mexican chiles, Mexican cushaw squash, and apples, as well as harvesting wild purslane and amaranth greens for home consumption. Pete Casados has been called a "farmer of the Old School" by the Albuquerque Journal, and their family farming heritage has been written up in Women's Day, Gourmet and Food and Wine. What is most intriguing is that skeptics who always claim that native food plants will be abandoned because "they don't fit the modern economy" are proved wrong by Pete Casado's success.

By growing his own adapted seedstocks which require modest

irrigation, and contracting with local Indian farmers on San Juan Pueblo lands for additional quantities, Casados has built up one of the largest reliable supplies of blue corn and other native foodstuffs available anywhere in the Southwest. Having grown up in the Hispanic-American farming community of El Guique nearby, he was already familiar with traditional farming skills and conditions in the region. Yet Casados did what few other Hispanic-Americans have done: he sought out and nurtured new markets for his produce. He gradually expanded and modernized his farming equipment, and his storage and processing facilities as well.

Today, he manages a harvest of as much as 40,000 pounds of blue corn in a single year. This ancient food is higher in niacin and protein than commonly available yellow corns (Calloway et al. 1975) and extremely popular in New Mexico style cuisine. Restaurants, ethnic food shops and markets pay premium prices for Casados' high quality cornmeal, blue corn atole and whole kernels. The Casados Farms also processes as much as 200,000 bushels per year of yellow corn as chicos, an adobe-roasted corn kernel ingredient used several (Casados 1981). Chile pequins (wild chiles), pinto beans, native long red chiles and other foodstuffs are processed or marketed by the Casados, but not all are grown on their property.

The strategy which sets the Casados family apart from other farmers growing the same plants is their active and innovate packaging of these attractive products as part of promoting the regional folk heritage. Juanita Casados (1981) booklet, New Mexico Delights, is an expensive introduction to recipes and lore associated with these foods. They combine bags and jars of several of these native foods

into deluxe gift boxes which can be shipped via mail order anywhere in the world. Through ads and through cooperating with journalists, they have promoted the use of these food plants to audiences which virtually have no other access to these ethnic specialties. In a sense, they are riding a wave of interest among gourmet cuisine connoisseurs. Financially, they have succeeded well.

The Casados family does not define their goal as genetic conservation, but they are proud that they maintain the Hispanic-American agricultural heritage of their region. They have contacts with a nearby branch of the New Mexico Agricultural Experiment Station, but have not directly donated their heirloom seeds to genebanks or botanical gardens. Nevertheless, their promotion of blue corn may do more for the long term conservation of this native crop than will the three dozen half pound accessions maintained by the USDA. By distributing thousands of pounds of blue corn kernels each year, som which are eventually planted elsewhere, Casados is keeping this native crop healthy and viable.

It is of historic note that county extension agents encouraged Hispanic-American farmers such as Casados to adopt high-yielding hybrid seed corn as early as 1946, but 96% of the farmers switched back to native corn within three years' time (Apodaca, 1952). Although its yield was three to four times greater than native corn, it had neither the proper texture, flavor, nor color. "It did not hand together well for tortillas," so the farmers' wives forced them to reject it.

Magnitude of Other Immigrant-American Farmer Efforts

Although small to moderate-sized farms operated by Immigrant-American families make up 78 percent of all farms in the United

States, they bring home only 19 percent of the total agricultural income, and most supplement that with off-farm wages. This leaves little time for most family farmers to engage in perserving their crop heritage, since strictly economic activities of immediate return must be of foremost priority. As J. Tevere MacFadyen (1984) argues, "Today's family farmer may still perceive himself in terms of the tradition he comes out of, but he is likely to have adopted the means and ends of agribusiness...."

The notable exceptions who maintain crop diversity cannot be tallied, because they are diffusely distributed and have never been comprehensively surveyed. Yet they no doubt have existed in all parts of the country: Gopher Broke Farm near Monticello, New Mexico; the farmer Jim Wilson grass seed farm in Polk, Nebraska; the Gene Lodgson orchard and grain farm near Upper Sandusky, Ohio, and the Cavagnaro's Pippindale Farm near Bolinas, California. These families have all taken unconventional approaches to marketing specialty crops, or supplement their income by writing and photo-documenting their innovative ideas. They draw upon crops of their own ethnic traditions or ones in their vicinity, but also experiment with exotic crops. Few, however, would define their operation's purpose solely in terms of genetic conservation, though in many cases it approaches an in situ harbor of crop and fruit diversity. Such farmers seldom pass on seed to gene banks or experimental stations, though they freely share them with neighbors. They are not generally recognized as protectors of genetic resources by government agencies, and some of the survivalist school explicity informed us they do not want the government to be aware of what they are doing.

GARDENER-CURATORS
John Withee:
The Extraordinary "Bean Man"

John Withee's managerie of bean seed has probably been the country's largest private collection of genetically valuable seed held by a single individual. His life-long commitment to preserving old and forgotten varieties of bean has made him affectionately known as "The Bean Man" to hundreds of gardeners who have enjoyed the heirloom varieites of beans that are available only because of his continued efforts the find and growout otherwise neglected types of beans.

Withee's quest began as an attempt to find the "Yellow Eye" bean variety he had relished as a boy growing up in Maine. His search expanded to include other varieties -- and to take up most of his time-off from his job as a medical photographer. Now retired, he grows 500 varieties of bean every year on less than two acres of spare land in Massachusetts. All told, he has collected about 1,200 varieties of beans. Withee deals with all five new world species of beans, though he mainly concerns himself with varieties of the common bean, P. vulgaris. He claims "their diversity in form, texture, color and taste [satisfies] every growing and eating requirement or desire among bean lovers." (Jabs, 1984)

Withee's bean preservation efforts has used the best scientific knowledge available whenever applicable on a garden-scale level, without disregarding folk knowledge about bean growing. In issues of Withee's Wanigan newsletter he provided articles reporting the latest scientific research on beans as well as such backyard gardening methods as stretching the growing season for long season beans by pre-

germinating them and starting them earlier in peat pots.

In growing out so many varieties of beans in a limited space, it could be easy to out-cross and contaminate the varieties. Common beans (P. vulgaris) are largely a self-pollinating plant, but they can cross-fertilize to reduce purity within old varieties. In runner beans, P. coccineus, outcrossing is the norm. To prevent this inadvertant out-crossing, gardeners can separate bean varieties 25 feet apart, or separate the varieties with another tall crop like corn. Withee, not having enough space for that, attempts to minimize this problem by planting beans with decidedly different characteristics side by side (for instance, seed size can vary by 500%). Then, if the adjacent plants do happen to cross-pollinate, he assumes that subsequent progeny will look different.

Around 1975, Withee realized he needed help keeping alive all the varieties he had collected -- bean seeds die if they are not planted and harvested for new seed every three to five years. "It's one thing to plant two hundred varieties," he explained, "But it's another to care for them, take notes, tie them up, and do everything that needs to be done." So he started Wanigan Associates, a non-profit organization whose name referred to the cooking shacks used by bean-loving loggers in Maine. Members of the organization could order beans from Withee's collection if they agreed to to return increased seed. Only 10 percent of the people who joined Wanigan Associates kept that agreement; many gardeners simply treated Withee's book of beans as yet another seed catalog. Withee still relied on just a handful of dedicated master growers with whom he exchanged the bulk of his collection so that it could not all be lost due to catastrophe in one locality. When one of these colleagues, Burt Berrier, died at the age

of 85, Withee increasingly sought the help of younger people. In 1981, overwhelmed by correspondence and unsorted beans, Withee decided to turn over the collection to the Seed Saver's Exchange and to the Rodale Research Farm.

Even though Withee was a diligent data-collector, there were numerous problems when these organizations attempted to assimilate this collection. Some seeds had not been grown since 1978, and had low percent germination. Others were labelled only by Withee's self-styled codes, or appeared to be mixes of growouts. If Withee himself had died before these problems had been worked out, a considerable greater percentage of the collection would have been rendered useless.

Fortunately, and perhaps in the nick of time, Kent Whealy of Seed Savers Exchange could evaluate the problem and coordinate rescue efforts to perserve of this vital genetic resource. Withee released 1186 varieties, but because of transfer difficulties Whealy only received 900 verifiable varieties, and some of these just tiny samples. The small and old seeds were grown out under the supervision of Dr. Charles Kaufmann and Peggy Haas on the Rodale farm in Kutztown, Pennsylvania, and returned after being increased there. In 1982, Whealy sent out 2500 packets to volunteers to grow out the collection, some packets containing perhaps 4 of some accessions, only 2 of others. He repeated this process in 1983. All totalled, 800-825 of John Withee's collection has been rescued, increased and computer-documented. Although none of the samples have been contributed to USDA storage facilities yet, that is one of Whealy's goals for this next year. Whealy has returned samples of 600 bean varieties back to Withee. (Whealy, 1985)

Magnitude of Efforts by Other Gardener-Curators

Withee exemplifies the impact which one person can have on crop's conservation, but he also demonstrates the problems which might arise if no one is capable of following in their footsteps. This problem is endemic not only to grassroots organizations -- the utimely shooting of David Cusack has severely set back Andean crop conservation efforts in the U.S. -- but to institutions as well. The National Research Council (1978) report on germplasm conservation noted that the USDA system itself depends on rare individual curators or breeders acting beyond the call of duty. When they die or retire, those who replace them may adequately meet the official job description, but seldom take on the extra chores of an exceptional curator.

The most well-known individuals who maintain large collections of seeds of one or more crops are those loosely affiliated with Kent Whealy's Seed Saver's Exchange. These tireless collectors often specialize: Ted Gibbs in more than fifty kinds of okra; Carl Barnes in dozens of ceremonial corns; Steve Neal in wild and cultivated potatoes; and Tom Knoche in squashes and gourds. These individuals have each passed on seeds or other propagation matieral to hundreds of other gardeners.

Perhaps there remain less than a hundred U.S. gardener-curators who maintain living collections of plants on the scale that these men do, yet we can surmise that this number is growing, not decreasing. Such hobbyist curators are often in touch with and gain the respect of USDA curators for their particular crops. Yet hardly any of them record the full documenation of characters found in the collections, and send this information and germplasm on to long-term genebanks. They are not eligible for USDA Plant Explorations grants or other

government support for copying notes, packaging and mailing seed to genebanks. Unless policy changes to offer modest support for such individuals, their collections will survive them only if younger individuals take over the responsibility for maintenance.

SPECIALTY CROP EXCHANGES
North American Fruit Explorers: Fruit Lovers Helping Each Other

Formed by a dedicated group of fruit-growing enthusiasts, the North American Fruit Explorers (NAFEX) is a nonprofit organization of 3,000 hobbyists banded together to share their "fruitful" experiences. It's prime purpose is to locate, test and preserve superior or special fruit and nut varieties regardless of their commercial importance, and their activities also include covering unique cultural methods/ materials, propagation techniques, fruit breeding procedures, and adaption of species and cultivars. NAFEX deals on a frequent basis with 21 woody, nut- or fruit-bearing species native to the North American continent, as well as introduced trees and shrubs (NAFEX, 1985).

The members of NAFEX started a round-robin letter to exchange information. "As the group grew," recalls Robert Kurle, the organization's corresponding secretary, "it took about three years for the letter to go through all the round-robin groups; so we started a magazine." The magazine, named Pomona after the Roman goddess of fruit, is published quarterly and consists largely of information gleaned from member observation of their fruit growing experiences. In fact, membership status carries the responsibility of contributing to the newsletter at least once a year. The best articles are collected

into occasional yearbooks that NAFEX sells. Subscribers can also borrow books from the organization's library (Jabs, 1984).

Essentially NAFEX is an institution that is defined by the activity of its members and their interactions with others interested in fruit. NAFEX members seek out old orchards and propagates heirloom apple, peach and other fruit varieties that were believed to be lost. Many search National Park and Forest areas for the long-abandoned homesteads of hill farmers whoe were moved out of these areas during the 1930s (Whealy, 1978). Both old and new varieties are tested by members, who report on their performance in different regions of the country. Outstanding varieties are brought to the attention of nurseries, which are encouraged to make them available commercially. Varieties are sought and exchanged through listings in Pomona.

NAFEX has an unpaid staff. Currently, they use a computer only for their mailing list; germplasm resources are still listed in a card-filing system, which they hope to computerize when they buy a bigger computer. One member, however, supplies computer searches of trees offered by a limited number of sources for cost (Kurle, 1985).

Although their self-definition is that of "hobbyists," NAFEX includes many amateur horticulturalists with specialized skills in propagating difficult plant materials. This technical knowledge and sophisticated skill is shared with others through workshops on grafting, air-layering and other techniques. The NAFEX annual meetings are usually held at government or university fruit development centers.

In their earlier years, following their formation in 1967, there was definitely a period during which NAFEX was unable to work very

well with government fruit introduction and conservation programs. They couldn't get any samples they wanted from regional plant introduction stations, since the USDA feared that once they started making fruit and nut tree genetic resources available to "hobbyists," they would soon be depleted due to a flood of requests. Now, a more reciprocal relationship has been developed with Dr. West at the USDA Clonal Repository at Corvalis, Oregon, the apple curators at USDA Plant Introduction Station at Geneva, New York, and Dr. George White, Plant Introduction Officer at USDA, Beltsville, Maryland. NAFEX has even gotten material out of the Soviet Union and China, with help in paperwork by the USDA.

One final example of the technical level of this group of "hobbyists" is a biotechnology research cooperative agreement NAFEX has with Japanese scientists to use tissue culture and test tube gene transfer techniques to get cold hardiness genes of the common persimmon into the Kaki persimmon. It is a larger, higher quality, less astringent variety. American land grant colleges weren't interested in helping them increase this species' cold tolerance because persimmons aren't an economic crop here, that is, there would be little research money available.

Magnitude of Efforts by Specialty Crop Organizations

The continuity and magnitude of organizations dedicated to individual or groups of field, tree and ornamental crops is impressive. We have tallied the names of more than 100 specialty or crop commodity societies, commissions, and councils in the United States, many of which include amateur growers who trade, conserve and display the diversity of forms found within a species (American Hort. Soc., 1983). They range from the North American Blueberry Council

oriented to commercial growers to the 23,000-strong American Orchid Society, Inc., which involves both amateurs and professionals. Cactus and orchid collectors have come under increasing pressure to slow their historic depletion of rare species from wild habitats in the United States and overseas, and there are significantly vocal elements within groups such as the Cactus and Succulent Society of America which now encourage bonafide in situ protection of endangered populatios. Many of these groups are in transition from being part of the conservation problem to being helpful in implementing solutions. Often, these groups have identified which varieties and species are truly rare long before government agencies have been able to. While some remain reactionary toward CITES and other regulations, there is no doubt that their members hold a considerable wealth of information about their target species. It remains to be seen whether all members of such groups will be sufficiently made aware of the threats of overharvesting to the extent that they will resist the temptation to collect one of the "last" _____.

REGIONAL EXCHANGES
Abundant Life Seed Foundation: Promoting Native Northwest Plants

Abundant Life Seed Foundation is a regional organization that "attempts to teach people about growing and collecting seeds." Located in northwestern Washington state, this non-profit organization deals with indigenous or naturalized plants of the Pacific Northwest, and serves mostly the people of that region with seminars, apprenticeships, a catalog of seeds and books for sale, and a calendar listing seed-collecting times for 350 wild plants.

Abundant Life Seed Foundation was founded 10 years ago by Forest Shomer who saw a non-profit organization as a better way to distribute seeds than the small solely-owned seed business he had started earlier. Fueled by his "single minded devotion to this task" Shomer's efforts has resulted in an organization of more than 10,000 members who share his enthusiasm for seeds. As he puts it, "A plant gathers different elements from its environment and combines them in one seed. When the seed ripens, it gets distributed and starts another cycle. We emulate that process, using paper, the mail, and human cooperation." (Jabs, 1984)

The foundation's annual budget of $80,000 (in 1983) was derived from the sale of books and seeds (seed sales are both mail order and through a regional distribution network of food cooperatives and garden stores), seminar proceeds and membership donations (Shomer, 1983). Although it has survived previous rocky financial times, the organization is currently seeking help to stay solvent -- in the form of a $10,000 short-term loan to capitalize improved seed marketing methods (Shomer, 1985a).

As a regional organization, Abundant Life Seed Foundation deals with plants either economically useful, beautiful, medicinal or native -- selling seeds of about 500 species every year (Niethammer et al., 1982), including ten plants of critical concern to plant breeding scientists. One of its goals is to undertake the gathering of 2,000 plant species native to its region. This year, they grew 200 seed crops on two acres of land, and hope to expand their own land-based propagation efforts to increase stocks of heritage varieties received from other collections, especially commercially scarce regional types

(Abundant Life Seed Foundation, 1985).

The Abundant Life Seed Foundation, because of its goal to educate people about seeds, networks with many people and groups throughout their region. It has been instrumental in establishing a formal regional coalition of seed growers, farmers, foragers, writers, networkers and others called the SeedPeople Network, which meets annually and is seeking support for a computer link up between groups. Both the Foundation and SeedPeople are associated with an international group, the Seed Action Network (SAN), an alliance of international non-governmental organizations concerned with genetic erosion affecting world food production (Shomer, 1985b).

Shomer's emphases, in both his teachings and the flavor of his organization, is on small scale, homestead-level production and harvest of seeds. Hands-on techniques, appropriate technology, and a connection with "new age" concerns can all be used to describe the nature of the technical level with which the Abundant Life Seed Foundation seeks to achieve its goals. It has gathered strong support from many people in the Northwest who can identify with these goals, who must find it easier to work with the human-scale techniques of seed-saving and propagation taught and supported by the Abundant Life Seed Foundation.

Magnitude of Efforts By Regional Organizations

In nearly every region of the U.S., there now exists either a non-profit seed exchange or small seed company specializing in garden vegetables, fruits or wildflowers which have finely-tuned adaptations to soil and climate. Most of these organizations are less than a decade old, and have arisen out of grassroot concerns in each region that widely-adaptable seeds marketed by international or national

firms where not wholly satisfactory.

Thus the Territorial Seed Company in Lorane, Oregon, sells seeds only to people living west of the Cascade Mountains. The Blue Ridge Seed Savers and the Southern Exposure Seed Exchange of Virginia specialize in heirlooms and other open-pollinated varieties particularly suited to the Mid-Atlantic region. Plants of the Southwest and the Talavaya Center, both of Santa Fe, New Mexico, carry native vegetables. The former also carries native grasses, wildflowers, halophytes for the arid West, as does Native Plants, Inc. of Utah, which also has a non-profit research branch. In the Northeast, Scatterseed and Johnny's Selected Seeds, both of Maine, feature but are not limited to vegetables suited to cool coastal climates. Both have donated seeds to the National Plant Germplasm System of the USDA.

In sum, the number of small regional seed exchanges and owner-operated companies has recently been increasing rather than decreasing. Few of these efforts have a stable financial base yet, nor is it clear whether all will be involved in long term conservation, since their inventories change quite a bit from year to year. To our knowledge, only the latter two have made significant contributions of rare varieties to gene banks. Instead, the value of these regional efforts has been in their distribution of otherwise unavailable seedstocks to hundreds of thousands of home gardeners.

IN SITU/EX SITU BRIDGES
Native Seeds/SEARCH: Scientists Gone to the Grassroots

One genetic resources group in the U.S./Mexico borderlands began

when scientists and agricultural development professionals turned their attention away from more academic interests to apply in situ and ex situ conservation concepts at the grassroots level. Native Seeds/SEARCH is a non-profit organization conserving and promoting native crops and their wild relatives in the arid, binational Southwest. Its attempts to bridge in situ and ex situ conervation strategies now involve 500 associates, extensive seed distribution, several crop conservancy gardens, endangered species petitions, seed banking, and a search for means to preserve critical habitat.

As a tax-exempt conservation and research organization, Native Seeds/Southwestern Endangered Aridland Resource Clearing House is new. However, its four founders had previously attempted some of the same activities under other auspices, with mixed success. Dr. Barney Burns, a dendrochronologist, had encouraged a native plant crafts revival among northern Mexican tribes. Mahina Drees, a garden extension specialist for the Meals for Millions foundation on the Papago Indian reservation, had previously assisted with Seri Indian foods studies. Dr. Gary Nabhan, ethnobotanist, had collected germplasm for the USDA in 25 Indian reservations. Karen Reichhardt, with an M.S. in botany, had done ecological studies for The Nature Conservancy and the National Park Service. Yet all of them searched for a more cohesive way to conserve plant diversity and the cultural heritage associated with it.

Native Seeds/SEARCH is the progeny of a request from Papago Indians for native crop seeds. When directed to the Meals for Millions Foundation gardening and nutrition project, MFM staffer Cynthia Anson tried to find a source of these seedstocks which were commercially

unavailable. Nabhan, who had been researching the crops at the University of Arizona despite limiting land grant funding support for such obscure plants, was delighted to find that his research might have practical benefit for the descendants of those Native Americans who had long-nurtured this genetic diversity. Nabhan joined Anson at MFM part-time, as did Drees, and they initiated the first Southwestern Traditional Conservancy Garden on lands at the Arizona Agricultural Experiment Station. It was later moved to Tucson Botanical Gardens.

After three years of expansion, culminating in hosting the Seed Banks Serving People international workshop in October, 1981 (Niethammer et al., 1982), this project budded off from Meals for Millions, which as a food and nutrition development organization could not indefinitely support a long-term seed conservation effort. With Meals for Million's blessings, Native Seeds/SEARCH incorporated in March, 1983. It grew to 214 associate members by June, 1984, and reached 500 associates in June, 1985. Seven part-time employees and several interns currently help with its projects.

From 57 crop land races available through Meals for Million's seed listing in 1982, Native Seeds/SEARCH has expanded its offerings to the public to 214 land races and their wild relatives, totalling 45 species. There were 3000 packets of seeds distributed by NS/S in 1984, and from January through June of 1985, 4180 packets had already been distributed. These are sold in $1.00 packets to interested gardeners to help further their availability and promote their usefulness. However, they are distributed free to researchers, individual Indian families and non-profit organizations. They have been provided to genebanks of the United States, Mexico, Guatemala and FAO, and to a dozen universities. Formerly-cultivated seedstocks have been

reintroduced to the Hopi, Zuni, Pima, Papago, Sand Papago, Cocopa, Mohave, Chemehuevi, Lower Pima, Mountain Pima, and Warihio Indian tribes. Whenever seeds are collected from these tribes, other land races from adjacent areas are offered in exchange, and attempts are made to encourage the Indian farmers to continue with the cultivation of their own rare seeds. If NS/S finds seed donors who have subsequently lost seedstocks, they are provided back to them without charge.

In situ conservation of native crops is dependent on factors other than the mere availability of seeds. Land, water and incentive are among other critical factors needed to maintain genetic diversity in the arid Southwest (Nabhan, 1985a). Native Seeds/SEARCH subsidizes in advance the growing out of surplus quantities of native seeds by certain Indian farmers, so that they have the economic incentive to spend extra time farming rather than working elsewhere for wages. It also provides nutitional and other information on these plants to cultural education programs, to encourage their local use.

In situ and ex situ conservation of wild relatives of desert crops is another Native Seeds/SEARCH activity. It is collaborating with the Arizona Chapter of The Nature Conservancy to find wild chile populations in natural habitats which can be acquired as protected reserves. It has also formally petitioned the Office of Endangered Species to consider the native grain, Sonoran panicgrass, as endangered in Mexico and already extinct (except in botanical gardens) in the United States. Finally, Drs. Burns and Nabhan have participated in IBPGR-funded wild bean collection trips in collaboration with Mexican scientists, and the entire board has collected maize for USDA

gene banking.

Recent maize, cucurbit and chile searches are being coordinated with electrophoretisis experts to determine genetic variation within and between populations, and to identify if "outlier" populations exhibit any distinct genetic characteristics. Once obtained, such information can help plan future exploration and conservation efforts.

In terms of collaboration with other organizations, Native Seeds/SEARCH is one of the few groups surveyed which has made an effort to exchange seed and data with neighboring Mexico, its scientists, conservation groups (eg., PRONATURA) and farmers. This is because it hopes to serve as a model for fostering reciprocal seed and cultural exchanges in an ecologically cohesive but binational desert region. Its board of advisors are scientists from the U.S., Mexico and Canada. In addition, NS/S staff has participated in the USDA Phaseolus Crop Advisory Committee, the Seed Saver's Exchange officers, and served as consultants to the IBPGR, the Desert Botanical Gardens, and to particular tribes.

As far as biotechnology's impacts on the genetic resources it is attempting to maintain, Native Seeds/SEARCH deals with numerous gene pools which were rapidly eroding even prior to the presumed impact of the Green Revolution (Nabhan, 1985a). Its staff feels that scientists who wish to "create new genetic combinations" have seldom spent enough effort screening available land races to see if such combinations already exist. In keeping with this concern, the only time Native Seeds/SEARCH has declined to provide seed to a plant scientist was when a land grant college professor asked for all its amaranth collections to induce new mutants through radiation treatment. The same scientist had obtained all these collections free of charge five

years before, but unwilling to believe amaranth had a high outcrossing rate, he lost the genetic integrity of the accessions by growing them out next to one another for three years straight. Instead of evaluating the new recombinants in controlled conditions, he abandoned them, and asked for new seed. Because radiation mutation has not resulted in any significant crop improvements after two decades (Jackson, 1984), the scientist was denied free seed but still had the option to buy $1.00 packets for his research.

The most heartening news for Native Seeds/SEARCH is that most researchers which have contacted them are willing to adapt their technical research skills to help a constituency different than that of conventional, large-scale agriculture. They have helped find better germination and establishment techniques for small quantities of rare seeds with poorly-known physiological attributes; verified outcrossing of wild fieldside gourds with cultivated squashes in remote Indian fields; offered help in classifying and screening corn, bean and cucurbit accessions; collected new accessions for NS/S stores, and even donated seed growouts from their research plots.

Perhaps Dr. Noel Vietmeyer's (1985) observations explain why scientists gain satisfaction in assisting with these efforts to conserve and document the value of these resources and their cultural contexts: "I felt I was standing on the edge of a dying horticultural frontier and could do little about it. [But Native Seeds/SEARCH] is acting. [They] have established a garden to preserve the Indian crops [and] augment this with a network of horticulturalists and plant scientists, all exploring the status and promise of traditional crops of the southwestern deserts... Rare seeds are offered to anyone

interested in keeping this native American crop heritage alive."

Magnitude of Efforts By Organizations Bridging In Situ and Ex Situ Conservation

The number of organizations actively concerned with both propagating rare plants and protecting their natural and cultural habitats remains small. Historically, groups arose out of either a gardening/horticulture upwelling of interest, or out of a conservationist/preservationist concern for wildlands. The genetic resources of those wildlands, and of relatively traditional farming communities, had few action groups looking after them. It has only been since the International Board for Plant Genetic Resources (IBPGR) and the International Union for the Conservation of Nature (IUCN) issued a report linking these concerns (Prescott-Allen and Prescott-Allen, 1981) that bridging efforts have begun.

Currenty, the IUCN's Ethnobotony Specialists' Group and the World Wildlife Fund's recently initiated plant projects are among the other examples of such linkages. UNESCO's Man and the Biosphere Program has encouraged a culturally-sensitive conservation approach in biosphere reserves in Mexico -- most notably in the Zea diploperennis farmlands of Jalisco (Guzman, 1985). However, in the United States, similar recommendations for encouraging native farming practices within biosphere reserves to maintain biotic diversity (Reichhardt et al, 1983) have fallen on deaf ears in the National Park Service and U.S. Forest Service. The USDA Plant Conservation policy statement (National Plant Genetic Resources Board, 1984) specifically dismisses in situ conservation as unstable and ineffective with regard to plant genetic resources. Such restrictive policy serves as a serious impediment to researching and implementing integrative in situ/

ex situ conservation efforts.

LIVING HISTORIC FARMS
The National Colonial Farm: Preserving Plants for Living History

Established in 1958 to preserve the view opposite Mount Vernon, the National Colonial Farm is run by the Accokeek Foundation, Inc., to depict a middle-class, eighteenth-century tobacco plantation. A visitor to the farm can almost step back in time to experience how a farmer would have lived in 1750. There's a fully stocked barnyard, a tobacco barn, a smoke house, a kitchen garden, a colonial crop demonstration area where major crops like corn and tobacco are included, and a herb garden boasting more than 50 herbs that would have been used by American colonists.

In addition to operating the farm for visitors, the Accokeek Foundation has a research program that explores questions in agricultural history, restoration of the American Chestnut tree, heirloom plant varieties, land preservation techniques, and native flora. The research is designed to both enhance the interpretive program at the National Colonial Farm as well as add to the general knowledge of these topics.

This research program has put National Colonial Farm at the forefront of collection and preservation efforts aimed to recover the varieties of plants that would have been used by American colonists. The National Colonial Farm has been growing heirloom varieties and saving their seeds for over two decades (Klein, 1984). Moreover, they are researching and establishing varieties in hopes of acquiring 100 varieties to exemplify the true colonial garden and farm (Jabs, 1984).

These special varieties are well tended by horticulturalists, who grow out and replenish seedstocks every two years, carefully screened to be true to type. Last year, 123 kinds of seeds, shoots and roots were preserved from the farm's fields -- 76 of which were heirloom varieties. In addition, the farm is dealing with 27 species of plants of concern to plant breeders.

When questioned as to the value of saving old varieties of seed, Dr. David O. Percy of the Colonial Farm likes to tell the story of the epidemic blight that destroyed 15% of the U.S. corn crop in 1970, caused by a fungus, Helmainthosporium maydis. Plant scientists who wanted to breed resistance to the fungus into subsequent corn crops were given access to an old variety of Virginia gourdseed corn that had been preserved at the Farm. (Percy, 1984)

The concept of preserving heirloom plants at living historical farms is promoted by people at the National Colonial Farm. "If each of the established living historic farms cultivated a hundred varieties common to its period and geographical area, more than 15,000 old varieties would be preserved in cultivation," said Dr. Percy (Jabs, 1984). While many historic farms might not have the resources to accomplish this, their efforts will be easier with the aid of a recent publication of Accokeek Foundation. Written by staff horticulturalist Mary Ann Klein, "Seed Saving Techniques of the National Colonial Farm," is designed to assist living historical farms develop and maintain heirloom seed and plant collections (Klein, 1984). It has clearly explained advice and procedures, and while it is written to be easily understood by a layperson, it illustrates the high level of scientific competance the farm has achieved in its genetic preservation program.

Magnitude of Efforts By Living Historic Farms

Since 1979 or earlier, the ALFHAM organization has regularly discussed the availability and authenticity of seeds exhibited by the member organizations. However, it was not until the publication of Percy's (1981) survey of practices at living historic farms that it became apparent how few of these working museums grew verifiably historic or native seed and rootstocks. Many of the 21 farms which were most interested in authentic period gardens renewed their efforts to conserve and document such heirlooms, and others have since joined in. ALFHAM, as of June, 1985, established an organization-wide committee to encourage and guide these efforts. Tom Woods of the Oliver H. Kelley Farm in Minnesota -- dedicated to the founder of The Grange -- is currently spearheading this research. Through other organizations, such as the Midwest Open Air Museums Coordinating Council, they are spreading the word to help others upgrade their conservation/education capabilities.

SUSTAINABLE AGRICULTURE EXPERIMENTERS
The Land Institute:
Genetic Diversity in Ecosystem Agriculture

The Land Institute does not define its overall goal as conservation of genetic diversity per se, but is clearly involved in the maintenance of diverse living plant collections with the objectives of soil, water, and energy conservation as they relate to agricultural sustainability. It is a nonprofit educational research organization located on 188 acres near Salina, Kansas, which functions in part as a plant introduction/evaluation field station for herbaceous, seed-producing polyculture. Under the direction of Dr. Wes

Jackson and Dana Jackson, a staff of 4 and 8-12 graduate students are actively evaluating the food production and soil fertility maintenance characteristics of numerous wild perennial grains, oilseeds and legumes adapted to semi-arid grassland zones. The Institute is attempting to develop a sustainable "ecosystem agriculture" that uses the ecological form and function of the prairie biome as its model.

Although the Land Institute is already maintaining a level of biological diversity greater than that found on nearly all commercial farms in the Grain Belt, Wes Jackson's review of ecological science literature has forced him to conclude that "diversity does not necessarily lead to stability" in natural or agricultural systems (Jackson, 1985). Rather than simply having a "diverse hodgepodge of species" loosely associated with one another in field crop production, Jackson is searching for natural "assemblies of plant species ...that do have histories of growing together," and therefore "interspecific complementarity" in terms of insect resistance, soil moisture and light partitioning, and nutrient cycling (Jackson, 1985). The Institute's students, under the supervision of Jackson and ecologist Judy Soule, have almost four years of data on the productivity of selected perennials, but the preliminary screening stage to find promising candidates amassed an enormous amount of data on the life histories and yields of 300 wild species adapted to the prairie biome.

To begin with, an herbary of 200 rows of native prairie and plains perennials was evaluated for two years by former staff ecologist Marty Bender. Bender made a significant number of collections himself over a seven state area in the U.S., including many of the 56 Rumex variants, but relied on Soil Conservation Service

Plant Materials Centers and the Prairie Plains Resource Institute for other accessions (Bender, 1980). Later, 4300 accessions of six perennial grass genera were obtained from the USDA ARS Western Plant Introduction Station and were evaluated (Pickett, 1982); 4000 of these have been maintained. Most impressive is the living plant collection of Eastern gamagrass, including 431 accessions, that has been observed for several years now on a plot near the entrance of the Institute's education and research center. Several genetically interesting variants have been found among these collections, including a mutant which converts a greater proportion of the Eastern gamagrass seedhead to seed-bearing rather than pollen-bearing flowers. Thus the Land Institute does not simply "maintain" a wide variety of samples; it scrutinizes available collections for the presence of characters potentially important in seed production, stress tolerance and soil conservation. Few, if any of these "uncoveries" have yet been redistributed back to the USDA although 300 accesions have been passed on to Peggy Haas for medium-term storage at the Rodale Research Farm.

A large number of plants used in early trial plants have already been eliminated as candidates for future polyculture experiments, but they are usually accessions which are also still stored in USDA genebanks. Jackson and plant breeder Walter Pickett also keep seed of many of these accessions in a short-term seed storage facility on site, in a barn storage room and in converted grain bins. Upgrading of these facilities or sending unique collections on to long-term gene banks would be necessary if the Land Institute were to see genetic conservation itself as one of its long-term goals. It does not presently define its mission as such, but as yet has lost very few trial species that have been planted in the herbary. Only a few, such

as Kings Ranch bluestem have 'escaped' to volunteer in adjacent prairie and roadsides.

The Jacksons have excellent ties with other "alternative agriculture" organizations, with many USDA forage breeders, and with open-minded scientists in a number of land grant colleges. They have exchanged improved or already-evaluated seed with the Rodale Research Center and the University of Illinois Crop Evolution Laboratory, but are not interested in providing material for genetic engineering experiments since Wes Jackson has argued that the philosophical and ecological weaknesses of the "biotechnology fad" in several widely-distributed papers (Jackson, 1984). Yet The Land Institute is one of the few organizations described in this report that is actively involved in the breeding of novel combinations of plant characters using conventional but sophisticated scientific methods. Although they do not anticipate producing a miracle crop or even a "perennial polyculture package" that will be acceptable to many farmers overnight, they anticipate that seed-producing perennials could revolutionize grassland agriculture within a half century's time (Jackson, 1985). Their financial support varies from year to year, but is relatively more stable and more adequate for the research being attempted than it was even five years ago.

Magnitude of Efforts by Ecosystem Agriculture Experiments

The Land Institute has no exact analog in any other bioregion in the United States. It is, however, part of a network of other sustainable/regenerative agriculture experiments which span the continent. Also of note are the New Alchemy Institute in Massachusetts, which combines regionally-adapted permaculture of fruit

and nut crops with controlled environment fish and vegetable production. The Rodale Research Center in Kutztown, Pennsylvania, currently maintains and evaluates several hundred accessions of herbaceous seed-bearing perennials, some of which have been passed on to gene banks. On the West Coast, the University of California's Agroecology Program at Santa Cruz, and the RAIN umbrella's Future is Abundant network share in applying the dynamics of diverse ecosystem agriculture. These latter groups do not, however, seek out and attempt to conserve already diverse agroecosystems found in the United States -- they try to build new ones. The major constraint limiting these groups' contribution to biotic diversity conservation is that they do not necessarily see that as their goal.

BOTANICAL GARDENS AND ARBORETA
Desert Botanical Garden: A Scientific Showcase

Founded in 1935, the Desert Botanical Garden is a non-profit educational institution located on 150 acres of Arizona desert surrounded by the Phoenix metropolitan area. The founders' aim was to develop "a natural garden of desert plants from the deserts of the world, so arranged that it will be pleasant for the layman to view, and yet can be studied by scientists." Research is carried on in the Earle Herbarium and the Richter Library. Educational programs are varied, open to the public and include lectures, classes, workshops and field trips. The Desert Botanical Garden is supported by memberships (currently 2271), contributions and admissions (Cole et al., 1985).

Originally the garden site was part of Papago Saguaro National

Monument, founded in 1914 to preserve the rich desert and unusual rock formations of this area. Abolished by Congress in 1930, the monument land reverted to state control, under whose authority the hobbyist group, Arizona Cactus and Native Flora Society were granted a petition to build the botanical gardens, 12 miles east of Phoenix's city limits at the time. In 1959, reflecting the rapid expansion of Phoenix, the state sold Papago Park to thhe city. Despite assurances to the contrary, the city reduced the garden's leasehold by half by constructing of a parkway that cut through the garden and by claiming land for park development.

Desert Botanical Garden has enjoyed steady growth except for the period during World War II. In 1942 it was forced to close. In the hands of one caretaker it fell victim to theft and vandalism. The adjoining military installation used it with reckless abandon as a drill ground. Shortage of gas made it difficult for loyal members to drive "way out there" to water plants (Fritz, 1985).

Today, the Garden boasts the display in a naturalistic setting of more than half of the world's different kinds of cacti and other succulents, trees and shrubs from arid regions of Asia, Africa, Australia, and the Americas. They list having 33 species of crops or their wild relatives native to the North American center of diversity. In their Index Seminum, in which they catalog seeds available to other botainical institutions, research stations and universities, 56 species are listed, but only three of these are genetic resources sought by crop scientists (Cole et al., 1985). They are harboring plants that have endangered species status. They believe that there are factors working to both increase and diminish their source of

germplasm: diminished due to increased land development, over-collecting and use, hybrid development, and red tape; increased with the development of germplasm collection centers and cooperation of various agencies.

The Desert Botanical Garden is a rather scientific, research-oriented operation, using the best technology available to botanists. However, their staff grew from a few self-trained amateurs to several advanced-degree biologists and horticulturalists over the last decade. Today, they seldom contaminate their stock by inadvertant outcrossing, and have an excellent computerized data management system regarding their living collection history. Their seeds are maintained in good quality medium-length storage facilties, and living collections of vegetatively propagated materials are given considerable weekly care. They do, however, have difficulty in propagation techniques of rarer plants, and must learn suitable germination and cutting establishment by trial and error.

Members are involved in the garden through a magazine, discounts to join classes and field trips, and bonus packets of desert plant seeds. The garden maintains ties with other similar institutions through several professional associations: the Arizona Botanical Garden Association (with six other Arizona gardens); the American Association of Botanical Gardens and Arboreta; the American Association of Museums; and the International Union for Conservation of Nature & Natural Resources Botanic Gardens Conservation Coordinating Committee. They are the lead desert-region institution for the new consortium, Center for Plant Conservation, engaged in USDA and OES approved propagation of U.S. endangered species. Interaction with University researchers has always been a part of the garden's

operations. When they have enough quantity (two pounds is required), seeds are sent to the USDA National Seed Storage Laboratory.

Although genetic conservation is only a part of the Desert Botanical Garden's mandate, it makes a tremendous effort for such a relatively small institution. This may be due to the historic influence of their research botanist, Dr. H.S. Gentry, formerly a USDA plant explorer for germplasm.

Magnitude of Efforts By Botanical Gardens and Arboreta

The 250-some public botanical gardens and arboreta within the United States harbor a vast and undocumented number of species, botanical varieties and ornamental cultivars. Although aesthetic concerns dominate the species selection and maintenance at more than half these gardens, there remain others in which conservation of useful plants is an overriding objective. For example, the Fairchild Tropical Garden in Miami boasts a bewildering array of tropical food plants which have recalcitrant seeds not suited to gene bank storage. It nevertheless distributes its viable seeds and cuttings to USDA Plant Introduction Stations, and has joined the Center for Plant Conservation. The Drug Plant Gardens and Laboratories of the University of Washington educates the public on medicinal and culinary herbs, but with a research rather than conservation focus. Other arboreta, such as the Missouri Botanical Gardens, are both regional and international leaders in wild plant conservation, with applied research activities of astonishing range and depth.

The large number of gardens and arboreta makes it impossible to generalize about the quality or magnitude of conservation programs. However, the new Center for Plant Conservation, coordinated through

the Arnold Arboretum and including 12 other organizations, has ushered in a new age of concerted, sophisticated efforts aimed at ex situ propagation of endangered North American species.

NATIONAL EXCHANGES
The Seed Saver's Exchange: Sharing Genetic Resources For All to Enjoy

The Seed Saver's Exchange is among the finest examples from anywhere in the world of a truly grassroots effort to conserve unusual and rare cultivated plants. Originally called the True Seed Exchange, it was established as a network of gardeners and farmers interested in swapping seeds of non-hybrid (standard) vegetable varieties, especially heirloom seedstocks that had been passed from generation to generation within rural communities. Although the adjective "true" was later dropped as the criteria for defining "trueness" became increasingly complex, Kent Whealy has remained true to his original goal of finding and saving open-pollinated land races of vegetables, grains and legumes. Along the way, Kent and Diane Whealy have completed an exhaustive inventory of all non-hybrid garden seeds still being offered in the U.S. and Canada -- an accomplishment that provides the first benchmark to monitor changes in seed availability through time.

In the winter of 1975-1976, a Kansan trained in journalism sent the idea of a "True Seed Exchange" out to Mother Earth News, Countryside, Landward Ho, and Organic Gardening and Farming, and all but the latter placed notice of Kent Whealy's proposal in a column of readers' communications. These laymen-oriented magazines had strong readerships among the back-to-the-land movement, in which Whealy and

his wife were interested to the extent that they bought land in a remote area of Missouri to build their own home and develop orchards and gardens to make their family self-sufficient. They accomplished most of these personal goals, but the increasing time needed to manage the Seed Saver's Exchange finally encouraged the Whealys to incorporate this network as a non-profit, tax-exempt organization. They have recently left their owner-built homestead to manage the organization and grow out 3000 vegetable varieties near Decorah, Iowa. As the organization grew (Figure 1, introduction), it gradually consumed upwards of 60 hours a week of Kent's time, and in spurts, as much of Diane's. Although Whealy (1975) was "at first... rather disappointed in the [lack of] response" to his proposed network, his members have now supplied other gardeners with approximately 4,000 heirloom or unusual garden seeds, "to make an estimated 250,000 plantings of varieties that weren't in any seed catalog and in many cases were on the verge of extinction" (Whealy, 1985).

In addition to serving as a forum for seed exchanges between members, Whealy's organization performs the following services: 1) attempts to assist those who are searching for a historic seedstock, or one that has been dropped from seed catalogs and is no longer commercially available; 2) coordinates a Grower's Network of assistance with increasing about 2000 kinds of beans, 600 tomatoes, 200 squash, 100 corns, and 100 kinds of potatoes; 3) educates members on backyard techniques for maintaining genetic integrity of rare seedstocks, and for maintaining viability of stored seeds; 4) informs members of other organizations and individual curators that have made significant efforts in conserving rare vegetable varieties; and 5)

serves as a forum for discussion of genetic conservation and related agricultural issues. Whealy made a considerable effort to inform his primarily rural audience of the debate on plant variety protection, assuming that such legislation would accelerate the abandonment of standard varieties in seed catalogs, and that most seed companies do not submit to gene banks their "obsolete seed varieties" when they decide to no longer market them (Whealy, 1979).

Whealy's members have pioneered the use of a number of technologies in the backyard garden and home that were formerly used only by government and university experiment stations. One such technology, the moisture-resistant three-ply envelope, is used to store seed for a longer period of time and in less space than needed byjars, boxes, and metal cylinders. Silica gel is used as a dessicant to decrease humidity in the seed's immediate environment prior to sealing the envelope (Bugbee, 1982). Dr. Bruce Bugbee and Dr. John Rahart helped Whealy work out seed volume-dessicant volume relationships and drying curves so that home gardeners without sophisticated equipment for measuring seed moisture content could use simple rules of thumbs to help better store their seeds (Rahart, 1983).

These efforts exemplify a different scale of technical research, with a different constituency in mind, than is normally done in the land grant colleges where plant physiologists like Bugbee work (Pennsylvania State University and Utah State University). Both Dr. Bugbee and the Seed Saver's Exchange should be commended for this innovative research, which will hopefully encourage others to use sophisticated science to assist home and community level seed conservation in solving its technical problems.

The Seed Saver's Exchange informally serves as an umbrella, or at least as a point of contact, between numerous other local and international groups concerned with genetic resources. Magazine-cover articles on Whealy's work have reached several million readers in the last few years. Carolyn Jabs' (1984) book on heirloom vegetable gardening was both dedicated to and intensively featured the Whealys and their network. The new Garden Seed Inventory (Whealy, 1985) has already been distributed to several thousand individuals and organizations, and can be used as a guide to purchasing seeds that appear on the verge of disappearance from commercial distribution. Out of the seeds offered by 239 companies and organizations listed in this reference, 48% are available from only one source. If that source had dropped a unique variety from its listing prior to Whealy's inventory, chances are that it would pass without notice or without attempts to include it in a gene bank or seed exchange. Today, numerous organizations are buying up the rarer varieties listed in the inventory, to solve this problem.

The effort which went into The Garden Seed Inventory has kept the Whealys from expending much time on membership-building within the last two years. Thus Seed Saver's Exchange membership has temporarily plateaued, and its support from foundations has never been secure for more than a year in advance. The Whealys have moved twice, gone through considerable personal hardship and financial difficulties in order to keep their organization afloat. Their next step, if the organization's financial base broadens, is the development of a vegetable heritage conservation farm in northeastern Iowa.

Magnitude of Efforts of National or International Seed Exchanges

The Seed Saver's Exchange is in many ways the most unique grassroots group in this report. It was not established to be an umbrella for other groups, but has generated so many crop- or region-specific spinoffs that it has become one by default. There are lesser-known analogs, and since Kent Whealy's group has only taken a decade to gain pervasive impact, perhaps one of these other organizations will flower in a similar manner.

The KUSA Research Foundation concentrates on ancient cereals and other foods of considerable antiquity, hoping to revive their nutritional use. The International Society for Lesser Known Useful Plants currently makes its base in Baja California, but formerly exchanged a wide range of species out of California, U.S.A. Both of these groups have had sporadic difficulties financially. Kentucky-based Plant Finders of America will attempt to track down "any plant in cultivation" any place in the world for a $5 fee. It refunds this per plant fee if the desired variety or species cannot be located. The National Association for Gardening, headquartered in Vermont, has a reader's plant finder service column in its widely-circulated newsmagazine, and is sponsoring a National Seeds Conference in October, 1985, at the Missouri Botanical Gardens.

These organizations offer a range of necessary services drawn upon by home gardeners, professional horticulturalists and educators. They are recent in origin, as a result of a groundswell of intereest in rare plants and genetic diversity among laypeople and professionals alike. Their limitation, if any, is that they are "user"-oriented. Many rarer plants, under more serious threats, may go unnoticed.

RESULTS

To what extent do living plant collections managed at the grassroots level play a significant role in maintaining the biological diversity of North America? Of the ten efforts highlighted here, major efforts are underway for conserving 107 species of crop resources and their wild relatives native to this continent (see Appendix D). These includes hundreds of uncommon land races and ecotypes of crops, and representatives of rare populations of certain wild species, some of which have been proposed as U.S. endangered species.

It is not surprising that a diversity of ethnic groups are involved in these activities, since cultures which are concerned about maintaining their identity through language, folklore and custom are "conservative" enough not to dismiss the value of their plant husbandry heritage. Indeed, this survey indicates that cultural heritage preservation is a major driving force for useful plant conservation. Cultures with strong agricultural traditions which have been fine-tuned to particular environments (deserts, foggy coasts) recognize the need for maintaining plants with special adaptations to those environments. Recurrent selection for better environmental adaptation over generations and generations has led to the development of the unique genetic resources which so strongly interest ecologists, physiologists and population geneticists today. As a "founding" population of a particular plant species is desseminated to different environments and exposed to new selection pressures, its gene pool diverges. The resulting diversity of ecotypes is what land-based farming communities have encouraged through their continued

stewardship of particular localities or regions, over decades or centuries.

As Americans became less tied to the land, and communities became "unsettled" (Berry, 1979) it appears that genetic erosion of these resources accelerated. At first, a few individuals or families -- the Cooleys and Casados -- defied this trend, and became seed-saving "specialists" for their communities. They simply persisted at cultural activities which were once commonplace. Then, individuals such as John Withee were motivated into attempting to conserve more kinds of crops than what his family would have in the past -- because he realized that if he didn't, his neighbors, relatives, and complete strangers wouldn't either. Perhaps fascinated by diversity itself -- nature in all its shimmering forms -- such gardeners-curators have played an invaluable role by saving many heirlooms just when their traditional system of stewardship was breaking down. Outstanding individual curators have in fact been the backbone of the USDA plant conservation efforts until recently (National Research Council, 1978).

Yet the Burt Berriers and Joseph Giffs who have lived the transition from subsistance farm to industrialized agriculture are now dead or close to dying. When some of these individuals die, certain seeds succumb with them -- just as Pima Indian Joseph Giff saw the last of his people's native tobacco buried in a grave with their seedsman (Nabhan, 1978).

Fortunately, there now exist networks of gardens, living historic farms and seed exchanges which can carry on after an exceptional seed-saver is gone. There has been rapid growth and maturation in these networks as their critical role in preserving millenia-old evolutionary lines of plants become more apparent. Perhaps the most

recent development is that these organizations are no longer limiting themselves to traditional techniques or conventional strategies for conserving these resources. Silica gel and paper/plastic/foil envelopes have replaced pottery jars or coffee cans for seed storage. Microcomputers have displaced notebooks, card files and handwritten labels for inventory maintenance. Electrically heated germinating pads with thermostats have taken precedence over tossing seeds directly out into the unpredictable conditions of the garden bed, when only a dozen seeds may be left in existance. Backyard gardener-researchers are studying quantitative population genetics to determine how best to maintain purity and variability within their rare heirloom seeds.

The gardens, community programs, living historic farms and heritage projects described here are rapidly increasing in popularity, economic stability and capability. Despite the ultimate reality of diminishing genetic resources due to a variety of pressures, these grassroots groups are handling more kinds of plants with greater skill, and fewer accidental losses. They still need to make additional advances in data management, in cooperation with long term gene banks, and in conserving genetic variation within populations rather than just more accessions. Nevertheless, they have grown from being the "hidden sector" in American plant conservation, to being internationally-acclaimed by the likes of the World Wildlife Fund, FAO and the U.N. Environment Programme.

If modern science and technology can better serve this effort, it is by shifting scale to answer questions and solve problems that relate to small populations of plants -- in some cases 10 to 250 individuals. When do genetic bottlenecks begin to detrimentally affect

population fitness? How can the grower effectively cross-pollinate plants within the population to maintain maximum genetic variability? How can the grower choose how many seed of each population variant to grow out this year, and how many to save back in case of catastrophe? Do outlier populations of a wild plant's gene pool express any characters not found within its core distribution? How can you tell when a seed has dried down enough for optimal storability without purchasing a $5,000 moisture content measuring instrument and without sacrificing the seed? How do you set up a provenience documentation program so that future users will know that Hopi lima bean collection X was found twining on Hopi corn collection Y, and should be evaluated for mutualistic responses?

Most of the grassroots participants surveyed are extremely thirsty for more pertinent scientific information, but skeptical of biotechnological fixes. They do not believe that genetic engineering will "make" so much new genetic diversity that our descendants will forgive us for the diversity being lost today. If there is any single underlying message of their conversations and writings, it is that we will be poorer culturally if we do not do all that is possible to conserve such remaining, often neglected natural resources.

Appendix A
FOOD CROPS NATIVE TO NORTH AMERICA

Although official U.S. Department of Agriculture dogma maintains that there is a "lack of native crops in the United States" (National Plant Genetic Resources Board, 1978; 1984), careful analysis of the archaeological plant record of North America suggests otherwise (Ford, 1981). Prior to the arrival of Europeans on the continent, the following domesticated food crops had evolved distinct varieties north of Mexico: grain amaranths; maize; common beans; limas; tepary beans; bottlegourds; pumpkins and hard-shelled gourds; cushaw squashes; butternut squashes; jack beans; Sonoran panicgrass; sunflowers; agaves; grain chenopods; sumpweed; native barley and two to three other grasses.

Native American wild foods which have become commercial crops include pecans; wild rice; jerusalem artichoke; sugar maples; blueberries; cranberries; raspberries; persimmons; hops; black walnuts; strawberries; plums; cape gooseberries; and muscadine grapes. A number of other native fruit and nut species have provided hardy rootstock or breeding materials to major horticultural varieties now grown on a worldwide basis. It is therefore difficult to accept the USDA assumption that "American consumers . . . would probably be shocked [if they] were asked to live on food from crops native to the United States" (National Genetic Resources Board, 1978). If the dozens of land races of these food crops did not provide enough diversity, the consumer could sample the 500-1000 more wild edible species found within the United States (Vietmeyer, 1985).

Appendix B

CONTRIBUTIONS OF NATIVE PLANT GENES TO MODERN CROPS

Great Northern Beans? Trace them back to a selection which the Will brothers made from the Northern Plains Indian, Son of Star. Mammoth Russian Sunflowers? Its history is partially obscured, but it appears that two Native American tribes' cultivated sunflowers were bred together, and superior selections made before the crop returned back to American soil. Blight resistant corn? One of many land races with this characteristic is Virginia Gourd Seed maize, a coarse white dent corn with kernels shaped like miniature gourds. Hopi Indian Mottled Limas? They saved the early California lima bean industry from going under, thanks to their root-knot nematode resistance. Concord and Catawba grapes? They likely evolved after introgression of introduced European grapes with the wild fox grape of the Atlantic seaboard. Strawberries? The most widely-cultivated varieties are all progeny of the hybridization of the wild Virginia strawberry with the wild Chilean strawberry, a chance event which took place in a European garden over 200 years ago.

In addition to these historic contributions to crop improvement, North American genetic resources are now being utilized for new purposes by modern plant breeders. The buffalo gourd, a wild relative of pumpkins, is being domesticated as a semiarid-adapted oil seed and root starch crop. A corn rootworm attractant useful in biological control of pests is extractable from its leaves. Meadowfoam, a winter annual wildflower native to the Northwest coast, is under study for the potential pharmaceutical uses of its longchain fatty acids. Jojoba, a desert shrub with unusual liquid wax in its seed, is already cultivated on 30,000 acres of the arid Southwest. Shampoos including a

few drops of it have been on the market for almost a decade.

Native American land races of cultivated crops are again being seriously genetically evaluated and utilized for the first time in decades. A fertility-restorer gene useful in producing hybrid sunflowers has been identified in Hopi Indian land races. Papago Indian tepary beans are being crossed with common beans to transfer heat, salt and drought tolerance to commercial bean varieites. Grain amaranths, first cultivated in New Mexico at the time of Christ, can now be found in breakfast cereal sections not just of small health food stores, but of Safeways as well.

Appendix C
PLANT HERITAGE MUSEUMS OF AMERICAN IMMIGRANTS

The ethnic groups immigrating to the American continent brought with them numerous Old World plants, carrying them in their luggage, in their purses and pants pockets. They also set up gardens in which to grow these plants, and sent back to their homelands numerous American vegetable curiosities.

The oldest living historic farm or botanical garden in the United States is reputedly the Bartram's Garden of the Philadelphia vicinity. John Bartram (1699-1777), a Quaker self-taught in plant taxonomy and horticulture, bought a 112-acre farm on the Schuylkill River in 1728. He soon afterward began to develop a garden there, at one time consisting of 2000 species propagated from seeds and roots brought back from the American wilderness or introduced from Europe (Mowers, 1979). European merchants engaged him as a plant collector, and he would ship them plant materials that he had evaluated at his farm. In 1765 George III of England appointed him Royal Botanist, and his son William Bartram continued this genetic resource exploration until his death in 1823. The garden, now just a 44 acres, is managed by the John Bartram Association, which attempts to cultivate the same 18th century perennial and annual plant varieties with which the Bartrams themselves were involved (Evens, 1982). It includes the progeny of the native Georgian tree, Franklinia alatamaha, discovered by John Bartram, but now extinct in the wild.

Other ethnic groups immigrating to to the United States have used botanical gardens and agricultural museums to show how farming traditions changed as they went from Old World to the New World. Old World Wisconsin is a 576-acre museum in Eagle, Wisconsin, which

emphasizes Danish, Finnish and Swedish farming traditions brought to the Midwest during the periods from 1831 to 1915. Its effort to conserve historic Scandinavian and American vegetable varieties was for several years driven by their former historic gardener, Jim Johnson, who researched and grew about 450 vegetable varieties introduced to the U.S. before 1888, some of which he traced back to the 1500s (Johnson, 1981). Johnson eventually retired from the farm to devote full time to historic research on pre-1930 fruits, flowers, grains and vegetables, and the authenticity of the museum garden has since diminished (Jabs, 1984).

The Old Cienega Village Museum near Santa Fe, New Mexico, demonstrates the orchid, herbal and irrigated field crops of Hispanic-Americans who settled the U.S. Southwest after the 1598 arrival of Juan de Onate and his colonists. Actually, it emphasizes the plant husbandry traditions of the Spanish, but includes certain New Mexican Indian plants as well. Native tobacco (Nicotiana rustica), culinary and medicinal herb seeds are informally distributed to visitors, and historic plantings, tillage, irrigation, harvesting and processing techniques are demonstrated for historic field crops such as blue corn, chiles and Spanish-introduced sorhum, and fruits.

The Arcadian House Museum in Saint Martinville, Louisiana, includes gardens around a historic plantation home of French-Canadian and Black immigrants to the Bayou region. Eighteenth century heirloom vegetables grown in the "Cajun and Creole tradition" there include cotton, tabasco and chow-chow chiles, okra, cucurbits, and the little known mirlitan, a chayote land race.

At the Park Service-managed Booker T. Washington National

Monument in Hardy, Virginia, the Burrought Plantation is managed as a Civil War-period living historic farm. Garden crops grown there are the same as those which Afro-American crop scientist Booker Washington would have been familiar with as a child: African-originated crowder peas and corn blight resistant gourd seed corn (Bearss, 1969).

These efforts are matched by equally interesting ethnic plant heritage exhibits elsewhere -- the Kipahulu District Living Farm Area of pre-1778 Hawaiian crops; the Navajo Nation Botanical Garden; the Dutch-oriented Old Bethpage Village Restoration in New York; and Old Sturbridge Village's apple orchards of over 100 historic varieites adapted to Massachusetts. Through the Association of Living Historic Farms and Agricultural Museums' (ALHFAM) 100+ members and the American Association of Botanical Gardens and Arboreta's 1000+ members, increasingly sophisticated and innovative approaches to living plant heritage conservation are being encouraged. Because they are visited by hundreds of thousands of people each year, these public museums, farms and gardens have tremendous potential for educating the public on the need to maintain useful biological diversity through living plant collections.

Appendix D

LIST OF NATIVE NORTH AMERICAN GENETIC RESOURCES MAINTAINED IN LIVING COLLECTIONS BY THE TEN GRASSROOTS ACTIVITIES SURVEYED

Acer saccharum - sugar maple
Agave deserti - desert agave
Agave mckelveyana - McKelvey agave
Agave murpheyi - Murphey agave
Agave parryi - Parry agave
Agave schottii - shindagger
Agave toumeyana - Toumey agave
Amaranthus cruentus - coxcomb amaranth
Amaranthus hydridus - wild amaranth
Amaranthus hypochondeiacus - grain amaranth
Amaranthus powellii - Powell amaranth
Amygdalus persica - peach
Atriplex canescens - fourwing saltbush
Atriplex wrightii - Wright saltbush
Bouteloua curtipendulia - sideoats grama
Camassia quamash - camas
Canavalia ensiformis - jackbean
Capsicum annuum - chile
Capsicum fiotescens - Tabasco chile
Carya illinoinensis - pecan
Carya ovata - hickory
Chenopodium berlandieri - huazontle goosefoot
Claytonia perfoliata - miner's lettuce
Cleome serrulata - Rocky Mountain beeweed
Cucurbita digitata - coyote gourd
Cucurbita foetidissima - buffalo gourd
Cucurbita mixta - cushaw squash
Cucurbita moschata - butternut squash
Cucurbita pepo - pumpkin
Datura wrightii - sacred datura
Desmanthus illinoiensis - Illinois bundleflower
Diospyros virginiana - persimmon
Euphorbia lathyris - gopher plant
Fragraria ovalis - western strawberry
Fragraria vesca - woodland strawberry
Fragraria virginiana - Virginia strawberry
Gossypium barbadense - Sea Islands cotton
Gossypium hirsutum - New World cotton
Gossypium thurberi - Arizona wild cotton
Helianthus anomalus - anomalous sunflower
Helianthus deserticola - desert sunflower
Helianthus grosseratus - thick-tooth sunflower
Helianthus maximiliani - Maximilian sunflower
Helianthus niveus - snowy sunflower
Helianthus salicifolius - willow-leaf sunflower
Helianthus tuberosus - Jerusalem artichoke
Humulus lupulus - hops
Iva annua - sumpweed
Juglans hindsii - California black walnut
Lagenaria siceraria - bottlegourd

Lesquerella gordonii - bladderpod mustard
Lobelia inflata - Indian tobacco
Lupinus perennis - long-lived lupine
Lymus arenarius - wild rye
Macroptilium atropurpureum - siratro
Nicotiana attenuata - Pueblo tobacco
Nicotiana quadrivalvis - four valve tobacco
Nicotiana rustica - Aztec tobacco
Opuntia ficus-indica - Indian fig prickly pear
Panicum sonorum - Sonoran panicgrass
Parthenium argentatum - guayule
Passiflora incarnata - apricot vine
Phacelia tancetifolia - valley vervain
Phaseolus acutifolius - tepary bean
Phaseolus filiformis - desert bean
Phaseolus grayanus - Gray bean
Phaseolus lunatus - lima bean
Phaseolus metcalfei - Metcalfe bean
Phaseolus ritensis - Jone bean
Phaseolus vulgaris - common bean
Physalis phyladelphica - tomatillo
Physalis pubescens - Cape gooseberry
Phytolacca americana - poke salad
Proboscidea louisianica - unicorn plant
Proboscidea parviflora - devil's claw
Prunus americana - American plum
Prunus besseyi - western sand cherry
Prunus maritima - beach plum
Prunus munsoniana - wild goose plum
Ribes cynosbati - pasture gooseberry
Ribes odoratum - Missouri currant
Robinia psuedoacacia - black locust
Rubus idaeus - red raspberry
Rubus occidentalis - black raspberry
Rubus cripus - curly dock
Rumex hymenosepalus - canaigre
Salix rigida - American willow
Salvia clevelandii - oily salvia
Salvia columbiarae - chia
Sesbania exaltata - sesbania
Simmondsia chinensis - jojoba
Solanum fendleri - wild potato
Solanum jamesii - wild potato
Tripsacum dactyloides - Eastern gramma grass
Tripsacum lanceolatum - Western gramma grass
Vaccinium ashei - rabbit-eye blueberry
Vaccinium corymbsum - highbush blueberry
Vaccinium macrocarpon - cranberry
Vitis arizonica - Arizona grape
Vitis labrusca - fox grape
Vitis riparia - riverbank grape
Vitis rotundifolia - muscadine grape
Vitis rupestris - sand grape
Zea mays - corn
Zizania aquatica - wild rice

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Contract Paper No. 2

Report on Grass Roots Genetic Conservation Efforts

Cary Fowler
Rural Advancement Fund

October 1985

Office of Technology Assessment
U.S. Congress

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REPORT

ON GRASS ROOTS GENETIC CONSERVATION EFFORTS

TO THE OFFICE OF TECHNOLOGY ASSESSMENT

U.S. CONGRESS

BY
CARY FOWLER
RURAL ADVANCEMENT FUND
AUGUST, 1985

Report On Grass Roots Genetic Conservation Efforts

This report examines grass roots genetic conservation efforts among individuals, religious and cultural groups, special interest societies, networking organizations, advocacy groups and seed companies.

Activity in all of these areas is high (with the exception of religions and cultural groups) and growing. Grass roots activities are particularly successful in conserving "heirloom" fruit and vegetable varieties. They are far less successful with grains, flowers and herbs. Some particular species, especially those that are biennial pose problems for the grass roots conservationists.

Data indicates, however, that grass roots efforts are responsible for conserving more heirloom varieties of many crops than is the federal government. And one organization has instituted an "early warning system" to detect varieties about to fall out of commercial trade. This organization considers such varieties "endangered" and acts to protect them.

But, the activities of individuals, some of the special interest groups and some of the smaller seed companies are vulnerable. Collections are lost when individuals die. Seed companies cease operation when financial losses outweigh the commitment of owners to remain in business.

Considering the number of species involved, the number of varieties held, the massive efforts underway to grow out and distribute these varieties, the presence of actual "seed banks" and the number of people involved, it would seem appropriate to recognize the existence of two distinct, somewhat complementary genetic conservation systems in the U.S.--one government operated, the other operated by a loose network of individuals, non-profit organizations and small seed companies.

The federal government has had very little interaction with this alternative system, though there are ample reasons why the government should seek closer cooperation. The two most obvious reasons are (1) the grass roots system has much material not now held in government collections and (2) this grass roots system is the natural domestic constituency of the federal program--the constituency that could possibly mobilize the political support the federal programs have often lacked.

This report suggests closer cooperation and lists a number of specific actions which could be taken.

REPORT

ON GRASS ROOTS GENETIC CONSERVATION EFFORTS

The organization of this paper is based on an outline prepared by the OTA. That outline called for an examination of the various categories of individuals and organizations involved in grass roots genetic conservation. This is followed by recommendations to facilitate better communication and working relationships between these groups and the government.

INTRODUCTION

Few people today can name more than four or five varieties of apples. To most Americans, an apple is an apple. Distinctions between baking apples, cooking apples, eating apples, dessert apples and apples you throw over the fence to the horses are fading memories to the elderly and mysteries to the young. Yet, in the last century over 7,000 named varieties of apples were grown in the U.S.[1] Over 2,600 varieties of pears were grown.[2] And thousands and thousands of distinct vegetable varieties were cultivated.

Outside the Vavilov Centers of origin and diversity for most major crops, the United States nevertheless generated

impressive genetic diversity as wave upon wave of immigrants arrived with their seed and settled in the different regions of the country. Then as now people wanted good crops--high yield and hardiness. But the small farmers and backyard gardeners also appreciated taste and cooking qualities. And many simply valued having a variety no one else had. At the base of any agricultural system creating or maintaining genetic diversity are individuals who value things that are different.

INDIVIDUAL EFFORTS

In southern North Carolina, a glass company worker named Jack Rice collects and saves butterbeans (limas) and field peas. In his forties, Rice has been doing this for over twenty years. Asked why, he will respond that his grandmother was a seed saver. But the real reason is that he likes the color of the stalks. And he is fascinated by the different leaf shapes. And of course he loves the taste. ("You can get a good broth from some of the heirloom varieties that you can't get from the ones in the store.")[3]

To understand why people collect and save "heirloom" varieties today it is essential to appreciate and accept the fact that stalk color, or leaf shape could be an important motivating factor. This might be difficult for most people to understand. But then most people are not involved in preserving genetic diversity. Those that are have their

unique reasons--as unique as the varieties they save.

After modest collecting, Rice realized one day that he had varieties "you couldn't buy anymore." He put a small ad in Progressive Farmer magazine and in a few other publications asking for heirloom butterbeans and field peas. He was swamped with mail. In fact, Rice still occasionally receives seed in the mail as a result of the ads placed years ago. Today he keeps 90-100 distinct limas and grows out half of his collection each year. The half not grown out are stored in his home (but not in a refrigerator). Rice claims that refrigeration does not increase germination percentages when the beans are stored for just one year. When harvesting seed, Rice discards any seed that appears to be the result of crossing between his varieties. Despite their reputation for not normally outcrossing, Rice's experience is that the "butterpea" family (small limas) outcross freely. Thus he separates those varieties during growouts.

Rice has been in touch with and has received seed from research stations in the U.S., Mexico, and Africa. He regards these experiences as positive. When asked if there were anything he would like to be able to say about government efforts, he responded by saying,"I wish they'd be more serious about it [collecting]. If I got something that's really an heirloom, they ought to want it. But they really don't." A recurring theme in people's comments during this study has been that while they have found that individuals

within the government have often expressed interest, this has been interpreted as personal interest rather than organizational interest. A man at a research station was curious about the performance of certain butterbeans Rice had. But it did not appear that the research station was interested. The importance of this distinction will be discussed later.

In Jack Rice's opinion, diversity in the crops he is concerned with has not been touched by either government collections or private efforts like his. He claims that many varieties are kept by poor blacks, whites and Indians in his county and expects the same is true elsewhere. Most people, but especially the poor, know nothing of the current concern over genetic resources. They know of no efforts to save rare varieties. The term, "heirloom," means nothing. They are simply planting grandmother's old beans--nothing anyone outside the family would find interesting. Indeed there must be thousands and thousands of people doing this--not on the scale of Jack Rice--but nevertheless preserving some unique varieties.

Young people involved in such efforts are often consciously involved. They have read articles about the "seed issue" and their participation is an expression of environmental or political concern often tinged with nostalgia and a longing for something old, something better. The interest of young people is encouraging, but it raises the question of whether

that interest is a passing fad.

The other major group of individual seed savers are the elderly. Political or environmental concerns are at best only recent rationalizations to add to a lifetime of seed saving. Many are "ornery" and set in their ways and opinions. Some have not so much of an appreciation for preserving all genetic diversity as for preserving their own variety of watermelon or apple which they believe to be "better" than any other variety in the world. But their collections are often impressive. (The 1200 plus bean collection of John Withee, a retired medical photographer in Massachusetts, is an excellent example.) Many of these collections are in imminent danger of being lost as the elderly lose the ability to maintain them. And it appears that this older generation will not be automatically replaced by those now in their fifties and early sixties, a group of people seemingly less involved in seed saving than those older and younger. Rice, though not old, has made arrangements to see that his collection is sent to a non-profit seed saving organization (the Seed Savers Exchange) in the event that something happens to him. In this regard, Jack Rice has assured the future of his collections. Few individuals involved in seed saving have such foresight.

[It should be noted that while the motivations that influence Rice to save beans are common to individual seed savers, Rice's degree of involvement and the size of his collection

are uncommonly large.]

EFFORTS AMONGST RELIGIOUS AND CULTURAL GROUPS

This author has been unable to find evidence of any substantial seed saving activities among religious or cultural groups. Seed savers exist amongst these groups but it is unclear as to whether they exist in larger numbers (which is doubtful) or whether these individuals are seed savers because of their affiliation with a certain religion or culture. Ivan Martin, perhaps the only active Mennonite member of the Seed Savers Exchange, was interviewed by phone from New York.[4] Martin has 38 varieties of potatoes including several he believes no one else has. He also has a few heirloom corn, bean, and sweet potato varieties. Of these he has only one--a string bean variety which he calls a "glass" bean--that he considers to be a "Mennonite bean." Martin regularly attends gatherings of Mennonite and Amish farmers. He and other Mennonite farmers spoken with over the past few years by this author confirm that when Mennonite and Amish farmers get together, they talk about the latest hybrids from Pioneer and DeKalb just like most other farmers.

The Cajuns of Louisiana may be keeping unique varieties of peppers and other vegetables used in their distinctive cuisine, but this cannot be confirmed at this time. Various Indian tribes are becoming increasingly interested in preserving their traditional varieties and organizations such

as Native Seed/SEARCH have devoted considerable effort to aiding them. Their activities (outlined below) are more fully described in another paper commissioned by the OTA titled "Special Interest Organizations".

Approximately twenty "special interest" organizations exist which focus their attention on a single crop, a group of crops or a particular region and which have some concern with genetic resource questions. These groups include:

> Native Seed/SEARCH. This non-profit organization promotes traditional agriculture and the use of native plants of the U.S. Southwest and northwest Mexico. It has been active in locating and reintroducing a number of Native American crops. Tepary beans, devil's claw, buffalo gourd, squash and amaranth are among the crops the organization has worked with and studied. Native Seed/SEARCH publishes a newsletter and is staffed by a small but impressive group of young professional scientists.
>
> Abundant Life Seed Foundation. Dedicated to the preservation of native and naturalized plants of the Pacific Northwest, it sells seeds of

open-pollinated traditional varieties of vegetables, herbs, native plants and flowers, most of which it multiplies itself.

The International Association for the Education, Development, and Distribution of Lesser Known Food Plants. Based in California, but active also in Mexico, it publishes a journal called Good and Wild.

American Gourd Society. Members exchange unusual gourd varieties through a newsletter devoted entirely to gourds. The Society sponsors an annual gourd show in Ohio.

Kusa Research Foundation. This small organization works with endangered varieties of cereal grains.

Fruit tree enthusiasts have formed several organizations which actively promote the use and conservation of rare fruit varieties. Notable are the California Rare Fruit Growers, the Home Orchard Society, the Worcester County (Massachusetts) Horticultural Society (founded in 1842, it has 1,100 members and operates a preservation orchard of several hundred old-time apple varieties and sells scion wood for grafting

and budding), and the American Pomological Society (founded in 1848, and currently having a membership of 900). One organization, Stronghold, Inc., exists for the purpose of saving the American Chestnut. It owns a grove in Wisconsin and is attempting to develop blight-resistant American chestnuts through irridation of the seeds and subsequent testing.

Perhaps most interesting among these groups is the North American Fruit Explorers (NAFEX). In the early 1960's Milo Gibson began to search out and find others interested in rare fruit varieties. Soon a round robin letter writing network was established. People would write about their experiences with locating old varieties or their methods of grafting or their problems with disease prevention and they would send this information to the next person on the list who would add material and send it to the next person. By 1967 this informal network had grown so large that it was taking 2 1/2 years for the collection of letters to circulate through the entire group. It was at this point that they decided to publish a magazine. NAFEX and its magazine, a quarterly called The Pomona, were thus established.

Today NAFEX has over 3000 members. Its president lives in North Carolina. Its vice-president is from Indiana. The Pomona is edited by a man in Illinois and printed in Wisconsin. This year's annual meeting will be held in West Virginia. The NAFEX Board of Directors is composed of people

from all sections of the country with the exception of the Far West. Both leadership and membership appear to be widely dispersed. Membership and participation are growing rapidly and a real sense of enthusiasm and loyalty is easily detected among members.

The organization maintains a lending library through the mail. And it occasionally gives small research grants. More impressive however is that it sponsors testing groups for many types of fruit. To facilitate information flow and as a service to members, the coordinators of each group are listed in The Pomona. Currently, NAFEX has groups on: acorns (sweet), apple, apricot, blackberry, blueberry, cherry, cherry plum, chestnut, citrus, currant, fig, gooseberry, grape, jujube, juneberry, kiwi, mulberry, paw paw, peach and nectarine, pear, persimmon American), persimmon (Kaki) plum, pomgranate, quince, rare brambles, raspberries, and strawberries.

The Pomona also lists the names and addresses of "consulting staff in special areas" to whom questions can be addressed. These areas include: budding, cuttings, espaliers, botanical sprays, soil improvement, variety testing, cultural practices-pests, grafting, pest control, pomology history, potted culture, soils and winter hardiness.

The Pomona is a publication of unusual quality, rare among organizations the size of NAFEX and rarer still in that it is

mainly written by the membership itself. The latest issue demonstrates these points. The organization's secretary contributed an article on interstemming pears. The article contains a detailed listing of old pear varieties that (1) show better fruit quality or tree characteristics on quince than pear; (2) can be grafted directly on quince; (3) need an interstem and (4) those whose compatibility with quince has not yet been established.

A Canadian member of NAFEX contributed a 75-item bibliography on cordons, palmettes and espaliers--methods of growing fruit that could help collectors grow many fruit varieties in a small amount of space. Dr. Elwood Fisher of James Madison University in an article entitled "Backyard Espaliered Orchard," notes that "One of my major objectives has been germplasm preservation."[5] Fisher describes a system which has allowed him to construct a preservation orchard containing 840 kinds of apples, 160 varieties of pears, 52 varieties of cherries, 27 plums, 15 peaches, 47 apricots, 20 grapes, 21 blueberries and many varieties of other fruits and berries--about 2,000 different varieties in all--on one-half acre of land.

Individuals like Fisher and his methods could have been enlisted to save the government's 1700 tree preservation orchard at Geneva, NY, which is in the process of being cut down due to lack of funds for maintenance. According to NAFEX officers, they would have been eager to get scion wood from

this orchard and saved it, if only they had been notified.

A USDA geneticist describes 50 old-time apples for the southern garden. And in a regular feature of the journal, members swap budwood, ask for help in locating certain varieties and offer seeds.

While NAFEX is a strong and growing organization and in no danger of demise, the organization is hampered by the fact that all funds come from the membership. No outside funding from the government or foundations has ever been sought or received and it is clear that NAFEX would not know how to go about seeking such funding. This constraint means that NAFEX is unable to hire any staff. The organization's treasurer, Robert Kurle, keeps membership records on his home computer (an AppleII), but longs for a hard disk that could accomodate all the records and allow for research. Kurle would like to set up a computerized list of varieties and where they are located--a grassroots version of the federal government's Fruit and Nut Tree Germplasm Inventory. But funds do not permit this.

Seventeen non-profit, special-interest groups like NAFEX were surveyed. Twelve (71%) responded. Of these most note that the varieties they help preserve come predominately from their own membership or their own collecting efforts, followed by government and public institutes. Commercial sources are unimportant. It would appear that these organizations and their members have access to many varieties not found in

commerce and not contained in official collections. This is especially true of fruits and possibly nuts, but less true of other food crops.

Of those responding to our questionnaire, most felt that access to heirloom varieties was expanding, and that public interest in and awareness of the problems of genetic erosion were also growing. With increasing membership and interest, old "lost" varieties are being found and placed in the networks of these conservation enthusiasts. Not surprisingly the organizations responded to the questionnaire in ways which would indicate that preservation/distribution of traditional varieties is a major and self-conscious goal of the organization.

NETWORKING AND SEED BANKING EFFORTS

A growing number of local and regional seed exchanges exist (several exist in the Appalachian Mountains, others can be found in the Pacific Northwest, for example). Collectively they are an important source - and an even more important "method" - for locating and saving traditional varieties of local prominence and value. Of these networking and seed banking organizations, one--the Seed Savers Exchange--stands out above all the rest in the scope and importance of its operations and in the role it plays in the grass-roots genetic conservation movement.

The Seed Savers Exchange is a relatively young organization that was begun almost accidentally. Kent Whealy had just married. His new grandfather-in-law introduced him to gardening that summer and Kent was enthusiastic. But during the winter his grandfather-in-law died. Kent realized that if the seed this old man had grown and saved year after year was not to be lost, it was up to him. The following spring Kent sowed the tomato, the pole bean and the morning glory seeds he and the old man had harvested the year before. And Kent began to wonder if other people were in his situation--responsible for the life and continued existence of a variety that held special meaning to them.

Kent Whealy started to talk to others. And in 1975, with six members he started the True Seed Exchange, later to be known as the Seed Savers Exchange (SSE). The first SSE publication was a six page newsletter.

Today the Seed Savers Exchange functions as a complement and as an alternative to the USDA's genetic conservation program. No one sees the two programs as competitors. But the range of activities, if not sometimes the scale, invites comparisons. The SSE maintains a seed bank. It has an impressive collecting program which includes mechanisms for obtaining endangered varieties. It grows out much of the material it stores and has a network of others that perform growouts for SSE. And it actively publicizes its activities and seeks to educate and involve the public in its work.

The backbone of the Seed Savers Exchange is its yearbook. The current edition spans 255 pages. In this yearbook the organization's 550 members are listed together with the varieties they are keeping. Being a member of SSE and being listed in its yearbook implies that you are willing to swap seeds with other members or in some cases send seed for a nominal cost to others.

The Yearbook contains valuable information on seed harvesting and storing techniques, updates on the political debates around genetic resources and other information (the 1984 Yearbook had articles on isolation distances for tomatoes and tips on maintaing corn lines, both authored by Ph.D's), but the bulk is taken up by single-spaced listings and descriptions of the thousands of varieties being offered by SSE members. This information is cross-referenced by crop. Thus if one knows that he/she is looking for seed of the Brandywine tomato, one need only find the tomato section and scan down the alphabetical list until Brandywine appears. A series of codes will then inform the reader as to who has that variety. More information about that variety and any conditions about obtaining it can be had from the section which lists SSE members by state. The Yearbook is sprinkled with photos of vegetables and the Whealy family and indeed the flavor of SSE is one of familiarity. The ties that are developed between seed savers in the pages of the Yearbook are strengthened at SSE's annual camp-out usually held in the

Midwest.

Several years ago members and others began sending Whealy seeds--sometimes of individual varieties, sometimes whole collections (most notably John Withee's massive bean collection from Massachusetts). In response, Whealy began seed banking and growouts in earnest. Shelves built along the north wall of Whealy's Iowa home now hold 3,200 airtight jars full of beans, peas and corn. All other seeds kept by SSE (as distinguished from SSE members) are kept in heat-sealed packets at 10 degrees Fahrenheit.

There is a three year rotation between growouts. On five acres of rented land, Whealy, his twelve year old son, and a SSE member/volunteer are growing out 2,034 varieties this year. This includes approximately 600 bean varieties, 400 varieties of squash, 300 tomatoes, 100 peppers, 150 potatoes, 125 varieties of corn (each hand pollinated), 100 watermelons, 100 cantaloupe, and a selection of varieties of other annuals. Truly dedicated SSE members participate in SSE's "Growers Network," by helping Whealy grow out the large SSE collection. Seeds are then returned to SSE for storage, distribution and more growouts. Some 2-300 people participate in this SSE activity. Of the 850 varieties of beans with sufficient stocks to be trusted to the growers network, SSE was able to "place" about 80% with a grower. About 50% were placed with two growers. In all, the growers network will make about 2,500 plantings this year.

SSE is maintaining about 3-4,000 varieties now. Whealy estimates that over the years about 4,000 varieties have been distributed to members and others in quantities sufficient to make 250,000 plantings of these heirloom varieties. By anyone's standards this has been a massive effort. One would have to assume that hundreds of these varieties would now be extinct were it not for the efforts of Whealy and SSE.

Three years ago the Seed Savers Exchange undertook the task of surveying the vegetable varieties being offered by the American seed trade. Whealy was concerned that the haphazard way both the government and SSE had of obtaining heirloom varieties was not enough to stem the tide of genetic erosion. It was not good enough to simply sit in the office and wait for someone to decide on his/her own initiative to send seeds. What was needed was an early warning system to alert the SSE to the impending disappearance of a variety while there was still time to obtain and safeguard the seeds. The result was a 448 page book entitled <u>The Garden Seed Inventory</u>. It inventories the non-hybrid vegetable and garden seeds offered by 239 seed companies in the U.S. and Canada.

At the outset Whealy was concerned with the "tremendous consolidation" occurring in the seed industry and the perceived threat to genetic diversity.

When a large corporation buys out a

small, regional, family-owned seed company, it invariably drops the former owner's collection of standard varieties and replaces them with the more profitable hybrids and patented seeds. The new corporate owners are only concerned with profits and usually switch immediately to generalized varieties which will grow reasonably well anywhere in the country, thus assuring the greatest sales in the company's new nation-wide market....Such losses might be viewed with less alarm, if the varieties being dropped had been superseded by superior ones as was often the case during the first half of this century. But the garden seeds currently being dropped from the catalogs are the best home garden varieties we will ever see. (emphasis in original) Almost all of the vegetable breeding being done today is for commercial application and such varieties seldom suit the needs of the home gardener.[6]

With over 2,000 varieties in his five acre garden, few would question Whealy's right to pronounce judgement on the qualities of the vegetable varieties being dropped from the

catalogs. But were deletions from the seed company catalogs really responsible for any meaningful amount of "genetic erosion" of American vegetable varieties?

Surveying 138 companies at the end of 1982, Whealy found that they had dropped 117 varieties that year. Some 237 varieties were dropped the following year according to hos survey of 184 companies. During the final year of Whealy's study, 239 companies deleted 263 varieties from their catalogs. Nearly 600 varieties in three years had been deleted. Those saved by either the National Seed Storage Laboratory or SSE had been saved largely by accident.

More alarming still, The Garden Seed Inventory reveals that over "48% of all non-hybrid garden seeds are available from only one source out of 239 companies![7]

This means that one company serves as the last commercial source for nearly half the non-hybrid vegetable varieties available to the American gardener and farmer. This in turn indicates the likelihood of massive genetic erosion in the U.S. in the near future.

In preparation for a forthcoming book on genetic resources, the Rural Advancement Fund compared Seed Savers Exchange (SSE) holdings with National Seed Storage Laboratory (NSSL) holdings. The Garden Seed Inventory indicated that 283 bean varieties were "endangered" by virtue of being sold by only

one commercial source. As the attached graphs show, SSE has 112 of these varieties, NSSL has 52. However, Whealy indicates that SSE has now placed orders for all remaining endangered bean varieties and received most. Thus the graph (prepared using only the data which we can confirm) is probably a very conservative indication of the percentage of such varieties actually held by SSE. Beans, tomatoes, watermelon, spinach and beets were examined. It was expected that the SSE network would have a large number of bean and tomato varieties, but a small number of spinach and beet varieties. But only in the cases of watermelons and beets does the NSSL collection contain more "endangered" domestic varieties than SSE. We also compared the actual varieties of these five crops held by SSE with the holdings of NSSL. The results were significant. In none of the five crops does NSSL have as many as half of the specific varieties held by SSE. Clearly, SSE has acquired and is now safeguarding a large number of varieties not held by the government.[8]

Thus far the U.S. government has made no visible response to this rather obvious threat to traditional American varieties. Dr. Louis Bass, director of the National Seed Storage Laboratory, recently observed that "We still receive these materials [heirloom varieties] from time to time from seed companies and individuals, but we do not have the facilities nor the people nor the wherewithall to search out and try desperately to locate things that should be in the collection that aren't there. We have our hands full taking care of what

we already have and what we continue to get from the international programs."[9] Scarcely any attempt has been made by the government to detect genetic erosion before the process is complete, while there is still time to act--perhaps because of the unwillingness of some to acknowledge any connection between the actions of the seed industry and the disappearance of traditional, heirloom varieties. But the SSE has not been forced to operate under similar constraints. Armed with their survey, they have begun to systematically buy seed of endangered varieties--endangered by virtue of their being offered by only one source as noted above.

The accomplishments of the Seed Savers Exchange are more impressive in light of the fact that their annual budget is only $40,000. This meager budget can be attributed to the fact that Whealy and others connected with SSE have devoted all their energies to the "practical" work of seed saving to the detriment of raising the money needed to keep the organization going. Small grants originally secured from the Soil and Health Foundation and the C.S. Fund with the help of the Rural Advancement Fund were not renewed regularly, perhaps because SSE never reapplied for more funds. The shortage of funds must be considered one of the two major problems facing SSE. This shortage does not pose a threat to the existence of the organization at this time, but it severely curtails the organization's activities and forces the Whealy family to endure the strain of overwork on limited

funds.

The second major problem faced by SSE is a problem familar to organizations operated by their tireless, dedicated, almost driven founders. How can other people become involved in leadership positions? How can the organization insure its survival when its fate is so closely tied to that of a single individual? It is not evident that SSE has grappled with such questions. Its board is small and both Whealy and his wife are members. At one point they constituted a majority. To remain healthy, SSE will have to change and evolve like the plants it seeks to protect. Long range program and financial planning, leadership development and administrative and managerial training are needed if SSE is to realize its full potential. (These types of problems are common among non-profit, voluntary organizations. While such problems pose a serious threat to the life and work of such organizations, they are essentially problems that the government cannot or should not solve. Those that could be addressed by government actions are noted in the "Recommendations" section of this paper.)

Whealy identifies SSE's specific needs as more funding, land (perhaps six isolated one acre fields for growouts), underground storage facilities for potatoes and squash, equipment to keep seeds stored in jars at a constant temperature, a greenhouse, and cabin facilities for garden apprentices.[10]

Thousands of varieties of fruits and vegetables are being conserved by the American public. Many, perhaps most of these varieties are not held in any government collection. Unfortunately the public effort falls short in the areas of grains and biennials. The SSE network for example, can boast only one or two individuals maintaining any sizeable collection of sorghum or barley. Corn is better protected, wheat apparently even less protected. Biennials fare only slightly better.

Until recently flowers and herbs were similarly ignored (with the exception of a "gene bank" established for a few flower species at the University of California--Irvine). But now an effort is underway by a SSE member to establish a sister organization for flowers and herbs. This fledgling and as yet unincorporated organization has 28 members and 60 subscribers to its 15 page yearbook. Because so little work has been done on flowers and herbs, it is impossible to guess at this point how much has been lost, how much material remains or what the public response will be to an organization founded to save such diversity.[11]

Before leaving the subject of "networking" organizations completely, it should be mentioned that several political advocacy organizations have played an important role in networking efforts. Principal among such groups has been the Rural Advancement Fund/National Sharecroppers Fund. The Rural

Advancement Fund (RAF) has for six years published a directory of sources of traditional varieties of fruits, nuts and vegetables. Over 25,000 copies of this directory have been distributed and it was reviewed in most of the major daily newspapers, thus exposing people to the notion of growing heirloom varieties while giving them the sources needed to participate.

Early in its involvement in genetic resource matters the Rural Advancement Fund organized opposition to extension of the Plant Variety Protection Act. The animosity created during this political debate five years ago still persists and has presented difficulties for joint government/private efforts to educate the public to the crisis of genetic erosion and the need for increased support to those government agencies addressing the problem.

Through numerous lectures, TV appearances, media interviews and its own publications, the Rural Advancement Fund has helped raise public awareness and perhaps has played a role in forcing more political attention to genetic resources issues. And it has helped organizations involved in practical conservation matters plan their programs and raise funds. RAF is hampered in its work in the U.S. by its increasing involvement in genetic conservation work abroad, by lack of staff skilled in the combination of genetics, economics and political science and to a lesser extent, by funding. RAF's activities are perhaps further endangered by significant

health problems that have been encountered in recent years by key staff people.

SMALL-SCALE SEED COMPANIES

Since the mid-1970's small seed companies have become an increasingly important source of heirloom vegetable and fruit varieties. There are now about 80 companies that offer significant numbers of heirloom varieties to gardeners and farmers through the mail. (Given the parameters of this study, 70 companies were sent questionnaires. 25, or 36% of the companies responded to our survey.)

One of the most innovative of the new seed companies is Seeds Blum of Boise, Idaho. Owner Jan Blum got into the business via her interest in backyard gardening and her concern over the takeover of family-owned seed businesses with the resulting decline in traditional varieties made available to the public. She obtained 3-400 heirloom varieties to grow out and test. Seeds Blum was incorporated in 1982. One thousand catalogs were mailed out. Fifty orders were received. Blum persisted. The next year she published twice as many catalogs and received eight times as many orders. For the 1985 season, Seeds Blum will distribute 10-15,000 catalogs.

Immediately Seeds Blum faced what must be the biggest dilemma that could be encountered by a new company wishing to offer heirloom varieties no other company sells--where do you

obtain the seed? During the first year of operation, Jan Blum multiplied the seed herself. But the business has grown. And Jan Blum's response to the problem has been unique. She established her own growers network made up of customers and others (sometimes those who had furnished the heirloom variety to her). Seeds Blum now depends on a core group of 50 growers to produce a major portion of its seed. Blum avoids some of the obvious quality control problems by keeping up close correspondence with her growers. If they are having problems, she is there to help. But the bottom line remains--she refuses to sell seed that does not meet her own high standards.

The Seeds Blum catalog is "user-friendly." It even lists and praises other seed companies on occasion. And the customers love it. Repeat orders are very high. And the company receives some 7-8 varieties a day in the mail from customers who want to donate material to a company they trust will help preserve it. The steady stream of heirloom varieties coming in leads Jan Blum to respond, "oh, definitely," to the question of whether sources of such varieties are expanding. Blum believes interest in heirlooms is increasing. She believes her company is uncovering old interest. And she believes it is all a bit faddish as well. The stability of her company is "real shakey" and is affected greatly by the press. Today the press is fascinated by heirloom varieties (and by a seed business run by two women--Blum and her partner). But that could change.

In many respects Seeds Blum is typical of the new breed of seed company that has emerged in the past decade. It is small and vulnerable, sustained by the enthusiasm of its founders and the growing loyalty of its customers. Still, many variations can be found. Of particular interest for this report are those companies that specialize in varieties from or adapted to their "bio-region". For example, Johnny's Selected Seeds of Maine specializes in varieties for short growing seasons, while High Altitude Gardens of Idaho offers seeds adapted to the Rocky Mountain region. The Abundant Life Foundation (not a commercial seed company) specializes in varieties for the Pacific Northwest and discourages people outside the region from ordering. A few companies specialize or deal exclusively in just one crop such as tomatoes, corn or sweet potatoes. An Oklahoma seed company, CORNS, maintains 500 varieties of open-pollinated corn.

Our survey of seed and nursery companies yielded some interesting data. Of those responding, the median founding date of the nurseries indicates that they are about ten years older as a group than the seed companies, all but one of which was begun in the 1970s and 1980s. Clearly, seed companies specializing in heirloom varieties have been a product of the times, a product of an explosion of interest in these varieties and in genetic conservation that took place in the 70s and continues today. This coincides with the debate over plant variety protection, the attention focused on seeds and seed companies due to the corporate takeovers of

the 70s and 80s and the upsurge in media attention. By contrast, interest in old fruit predates these events. While new nurseries have sprung up to supply the heirloom varieties (several now offer well over 100 different apple varieties), most of the nurseries were founded in the 60s or earlier. Several of the older nurseries will cease operations in the next few years due to the age of their owners. If government collections are to include their apples and other fruits, the time to act is now. In general the nurseries are smaller. Only one respondent stated that they had over 500 customers. More than a third of the seed companies responding claim to have over 5,000 customers. Perhaps because of operating costs and profit margins however, it would appear that the nursery businesses are more vulnerable from the age of the owners, while the seed businesses are vulnerable from having too few customers. Many of the seed companies surveyed are operated by people who are forced to have other jobs in order to support their small seed company. A number of these companies will go out of business in the coming years. This will decrease the public's access to heirloom varieties. Only five companies indicated they had ever been contacted by the USDA National Seed Storage Laboratory, a regional plant introduction station or a representative of the National Plant Germplasm System. Thus government collections also stand in danger of losing access to varieties when the smaller of the companies fall.

The great majority of seed and nursery companies and special

interest groups regard themselves as part of a larger community of people who appreciate heirloom varieties and try to preserve them. Specifically, most mention that they are in contact with the Seed Savers Exchange, which they regard as a focal point for conservation efforts as well as a source of varieties for possible commercial use. To a lesser extent these companies and organizations also see themselves as part of a political/ecological movement and in this respect regard the Rural Advancement Fund as the focal point for such efforts.

Relations between grass roots organizations and the federal government are difficult to characterize. Our survey respondents generally offered praise for the individuals within government they had encountered. But some voiced criticism for what they see as an apparent lack of commitment on the part of the government to genetic conservation work. And they were particularly critical of the germplasm system's lack of interest in heirloom varieties found in the U.S.

For the most part it would seem that the government has ignored grass roots efforts. But often grass roots organizations feel that when the government does comment on their efforts, the government's attitude is condescending, even hostile; a "reluctance to interact on 'lesser levels'", as one non-profit organization's founder put it. At some of the highest levels within our country's germplasm conservation system, there would appear to be a serious

attitude problem. If the government and grass roots organizations are to work together in the future, the government will have to acknowledge the legitimacy, the sincerity and the value of grass roots efforts! Sadly, the government has ignored, and in some cases insulted and alienated the only constituency it has amongst the general public. If government programs are to be properly funded, if genetic erosion is to be halted in our own country, the government will have to enlist the popular support and political influence of those who already care and who are already acting. The non-profit organizations and seed companies discussed in this report and the thousands of supporters and customers they have represent the real constituency for support of USDA genetic resource programs. They could be just as important to USDA funding in this area as environmentalists are to national parks funding or veterans are to VA funding. Failure to tap support from this constituency diminishes the overall government effort in demonstrable ways. If, on the other hand, the government has scientific reasons for not caring about heirloom varieties or increased public support, those reasons should be voiced.

RECOMMENDATIONS

What follows is a listing of suggestions and ideas for actions the government might take to improve communication with grass roots organizations, facilitate greater grass roots involvement and participation, and encourage government

and grass roots conservation efforts.

These suggestions are made with the assumption that grass roots efforts are valuable and effective today and that many of the measures that could be taken to improve those efforts are outside the scope of government assistance. One of the strengths of grass-roots efforts is that they are grass-roots. They do not depend, nor should they, on government funds or expertise. The distinction between government and voluntary programs is healthy and should be respected. Nevertheless, there are ways in which communication, coordination and cooperation could be increased to the benefit of all.

"Establishing Better Communications"

Grass roots organizations and small seed companies operate independently of and largely without any significant or ongoing communication with the government. Steps must be taken to end this isolation. The government (at its own initiation) should meet with grass roots organizations and small seed companies. The consequence of the National Plant Germplasm System's not reaching out to grass roots organizations and small seed companies is that it ends up serving (or is perceived to end up serving) mainly large corporate and institutional interests. Furthermore, both grass roots organizations and the government lose the benefits each has to offer the other.

To insure that this communication is ongoing, the government should have someone on the staff (perhaps at Beltsville) designated to act as a liason between government programs and the public in general and grass roots efforts in particular. In the interim, the government should publish a brochure or booklet to explain exactly what the government can offer to grass roots organizations and small seed companies. This booklet should explain specifically how the government wishes to be approached for assistance--what the ground rules are, what procedures should be followed.

These are the actions that would need to take place to establish the most basic "diplomatic relations" with the grass roots community.

"Allowing Grass Roots Involvement and Input"

Both grass roots organizations and the government have much to offer each other. The government has scientific expertise, permanent structures and a knowledge of the practical uses of genetic resources. Grass roots organizations offer enthusiasm, expertise in certain catagories of genetic resources (and the actual material) and the potential for political support for government programs. To take advantage of these strengths, individuals representing grass roots organizations and small seed companies should be appointed to the National Plant Genetic Resources Board. This would be a

welcomed signal of interest and a gesture of good faith and it would help insure grass roots input into national policies. More importantly, such appointments would finally place the government in compliance with federal statutes covering USDA advisory committees. These statutes (7 U.S.C. 2281 et. seq.), the regulations of the Department on advisory committee management (7 CFR 25) and the Federal Advisory Committee Act (FACA) supply the applicable law in this instance. They mandate, for example, that "membership for the advisory committee represents a balance of differing views" and that such bodies be composed of "a balanced membership reflecting the differing views of the groups substantially affected by matters to be considered..." The Secretary would appear to be obligated to prepare a "statement concerning the plan to achieve balanced membership on the advisory committee". In addition, the inclusion of women and minorities may also be indicated, though this is not completely certain.

The government should establish a clear structure for dealing with heirloom varieties by constituting a Crop Advisory Committee on heirloom varieties as recently recommended by Dr. Gary Nabhan. Discussions have taken place on enlarging the responsibilities of the CAC's and the National Plant Germplasm Committee is "preparing a paper on the scope and role of the CAC's," according to the minutes of the May 9-10 meetings of the National Plant Genetic Resources Board. This presents an opportunity for the NPGC to stress the importance

of grass roots activities to CAC chairpersons. According to these same minutes, "...CAC composition is approximately 41/36/23% among Federal, State, and industry, respectively." Obviously, those three entities are not the only ones with concerns about individual crops. The opportunity exists to broaden those catagories to include representatives from grass roots organizations and small seed companies on appropriate CAC's.

"Encouraging Government/Grass Roots Conservation Efforts"

The government should actively seek to include material now in the grass roots conservation system in its own. As indicated above and in the accompanying graphs, the grass roots system has material that the government does not have. The government should establish easier ways of sharing its own material. It is possible that some old varieties now in government collections could be reintroduced into commercial channels through small seed companies.

In order to help prevent genetic erosion in the U.S., the government should cooperate with the Seed Savers Exchange on SSE's "early warning system" of genetic erosion and should act together with SSE to acquire these endangered varieties. In addition it may be worthwhile to explore how grass roots organizations can be better linked into the government's Genetic Resources Information Network (GRIN).

Growouts pose a financial hardship on the government and present an opportunity for government/grassroots cooperation (as well as a possible source of funds for organizations). The government could enlist the help of grass roots organizations in growing out material currently stored at the National Seed Storage Laboratory. NSSL growouts are not being done frequently enough and the cost of such growouts is currently in the range of $150-200 per accession. At the lower rate, SSE will perform over $300,000 worth of growouts this year on a total annual organizational budget of $40,000. The government may want to offer training sessions for organizations performing growouts to insure that the growouts are done according to government standards. Assuming proper precautions, the government could increase the frequency of its own growouts, substantially lower the costs and involve the public all at the same time.

Government programs, small seed companies and non-profit organizations would all benefit from increased awareness of the issue of genetic resources. All are financially vulnerable to a decline in public support. Thus it is crucial that the government consider initiating a massive public education campaign to raise the awareness of the public to the importance of genetic conservation. While public interest in this subject has skyrocketed in recent years it would be difficult to point to anything the government has done that is responsible for that new enthusiasm. It is time the government joined the grass roots organizations who are

responsible for that change in the public's interest and began to treat the problem of genetic erosion with the seriousness it deserves. No one (until recently) thought it inappropriate that the government had Smokey the Bear to urge people to save forests. Everyone knew forests were important. Are genetic resources less important? An heirloom garden on the lawn of the White House and a media campaign would not be inappropriate beginnings. Such a campaign might even culminate with the establishment of a national conservation fund modeled after the National Endowment for the Arts or the Corporation for Public Broadcasting. Such a fund could provide the appropriate vehicle for supporting grass roots conservation efforts while increasing financial support and visibility for government programs.

Seed companies surveyed had additional ideas for how the government might assist them. And they had many questions. For example, they wanted to know if experiment stations would test heirloom varieties for small seed companies in the same manner that they test new introductions for large companies. Could testing be done through the extension service's master gardener program? How would the results of such tests be handled? Would they be fed to larger companies, who might use the information to seek patents? Could the extension service and ASCS publicize heirloom varieties in the same way that they recommend modern varieties? Could small seed companies get information from extension agents on which heirloom varieties performed the best in their county?

Such questions indicate a need for greater communication between the USDA and small seed companies and perhaps greater sensitivity at USDA to the fact that "industry" also includes seed companies that happen to be small.

CONCLUSION

In summary, grass roots organizations, small seed companies and individuals are engaged in preserving a significant amount of genetic diversity not found in government or institutional collections.

Many of the varieties being saved (as illustrated by the attached graphs) are not to be found in government collections. It is important to realize that the U.S. actually has two, distinct, potentially complementary genetic resource conservation systems. One is government operated. It emphasizes foreign accessions saved with the benefit of sophisticated technology. The other genetic conservation system--the grass roots system--is comprised of a network of non-profit organizations, individuals and small seed companies engaged in preserving traditional "American" cultivars. This system depends on public participation. Lacking money and technology, it substitutes involvement and enthusiasm. The first step towards making these systems complementary is for those involved in both to recognize the existence, legitimacy and value of the two systems. Neither

system could easily duplicate the activities of the other.

If the material in the grass roots system is valuable (it would be difficult to argue that it is not since the government is not in a position to evaluate it), then the efforts of these groups are certainly valuable.

Due to the educational campaigns undertaken by these organizations, public awareness has increased significantly. Newspaper and magazine articles on genetic resources are reasonably common. Documentary TV programs are being made (NOVA in the U.S. and CBC in Canada).

All of this has been accomplished with virtually no encouragement and little practical aid from the federal government. Yet neither grass roots efforts nor government efforts can accomplish alone what either needs and wants to accomplish. As important as grass roots activities are, they are also fragile and vulnerable. Given the pace of genetic erosion both outside and inside the U.S., could there be a better time to seek ways to improve both grass roots and government programs?

[1]Ragan, W.H., Nomenclature of the Apple: A Catalogue of the Known Varieties Referred to in American Publications from 1804 to 1904, Washington, D.C.: USDA, 1926.

[2]Ragan, W.H., Nomenclature of the Pear; A Catalogue-Indes of the Known Varieties Referred to in American Publications from 1804 to 1907, Washington, D.C.: USDA, 1926, 269 pp.

[3]Rice, Jack, Laurinburg, North Carolina, personal communication, 1985.

[4]Martin, Ivan, Penn Yan, New York, personal communication, 1985.

[5]Fisher, Elwood, "Backyard Espaliered Orchard," The Pomona 17(2):119-123, 1985

[6]Whealy, Kent, The Garden Seed Inventory, Decorah, Iowa: Seed Savers Exchange, 1985, 448 pp.

[7]Whealy, Kent, ibid., p. 8.

[8]Fowler, Cary, and Pat Mooney, Shattering, Chapter 9 of manuscript of forthcoming book.

[9]Bass, Louis, Remarks to the Association of Living Historical Farms and Agricultural Museums Conference, Williamsburg, Virginia, 1985.

[10]Whealy, Kent, Williamsburg, Virginia, personal communication, 1985.

[11]Bond, Barbara, Nebraska City, Nebraska, personal communication, 1985.

METHODOLOGY

Telephone and personal interviews were conducted with individuals, organizations and the companies highlighted in this report. In the case of the Seed Savers Exchange, the North American Fruit Explorers and Seeds Blum, extensive written information - their own publications, articles, and letters - was also available. Personal correspondence was also received from all.

Open-ended questionnaires were mailed to 70 companies known to specialize in heirloom varieties. Twenty-five were returned, for a 36% response.

Similar questionnaires were mailed to 17 non-profit organizations engaged in genetic conservation efforts. Twelve were returned, for a 71% response.

Copies of both questionnaires are included with this report.

Non-Profit Organizations Sampled

Seed Savers Exchange - Iowa

Native Seed/Search - Arizona

Abundant Life Seed Foundation - Washington

International Association for the Education, Development, and Distribution of Lesser Known Food Plants - California

American Gourd Society - Ohio

Kusa Research Foundation - California

American Pomological Society - Pennsylvania

California Rare Fruit Growers - California

Home Orchard Society - Oregon

International Dwarf Fruit Tree Association - Michigan

North American Fruit Explorers - Illinois

Northern Nut Growers Association - Connecticut

Worcester County Horticultural Society - Massachusetts

Colonial Williamsburg - Carter's Grove Agricultural Project -

- Virginia

Stronghold, Inc. - Maryland

Scatterseed Project - Maine

Oliver H. Kelley Farm, Minnesota Historical Society - MN

Seed Companies Sampled

Alston Seed Growers - North Carolina

Butterbrooke Farm - Connecticut

California Gardeners Seed Company - California

CORNS - Oklahoma

David Crockett Company - Ohio

Exotica Seed Company - California

Fred's Plant Farm - Tennessee

G. Seed Company - Washington

Garden City Seeds - Montana

Greenleaf - Massachusetts

Hastings - Georgia

High Altitude Gardens - Idaho

Horticultural Enterprises - Texas

Johnny's Selected Seeds - Maine

Kalmia - Virginia

D. Landreth Seed Company- Maryland

Land's End Seed - Colorado

Le Marche Seeds International - California

Long Island Seed and Plant - New York

Neal's Open-Pollinated - Iowa

Nichol's Garden Nursery - Oregon

Peace Seeds - Oregon

Peter Pepper Seeds - Tennessee

Prairie State Commodities - Illinois

Redwood City Seed Company - California

S & H Organic Acres - California

Seeds Blum - Idaho

Southern Exposure Seed Exchange - Virginia

Tater Mater - Missouri

Territorial Seed Company - Oregon

Vermont Bean Seed Company - Vermont

Vita Green Farms - California

Week's Seed Company - North Carolina

Westwind Seeds - Arizona

Willhite Seed Company - Texas

Wilton's Organic Seed Potatoes - Colorado

A World Seed Service - California

W. F. Allen & Company - Maryland

Baum's Nursery - Connecticut

Bear Creek Farms - Washington

Boston Mountain Nurseries - Arkansas

Converse Nursery - Massachusetts

Culver Nursery - California

Earl Douglass - New York

Finch Blueberry Nursery - North Carolina

Florida's Vineyard Nursery - Florida

Dean Foster Nurseries - Michigan

Louis Gerardi Nursery - Illinois

Greenmantle Nursery -

John Goodson - North Carolina

Hartmann's Plantation - Michigan

Hidden Springs Nursery - Tennessee

Ison's Nursery and Vineyards - Georgia

Johnson Orchard and Nursery - Georgia

Lawson's Nursery - Georgia

Henry Leuthardt Nurseries - New York

Living Tree Centre - California

Makielski Berry Farms - Michigan

Raintree Nursery - Washington

Saginaw Valley Nut Nursery - Michigan

Simpson Nurseries - Florida

Sonoma Antique Apples - California

Southmeadow Fruit Gardens - Michigan

St. Lawrence Nurseries - New York

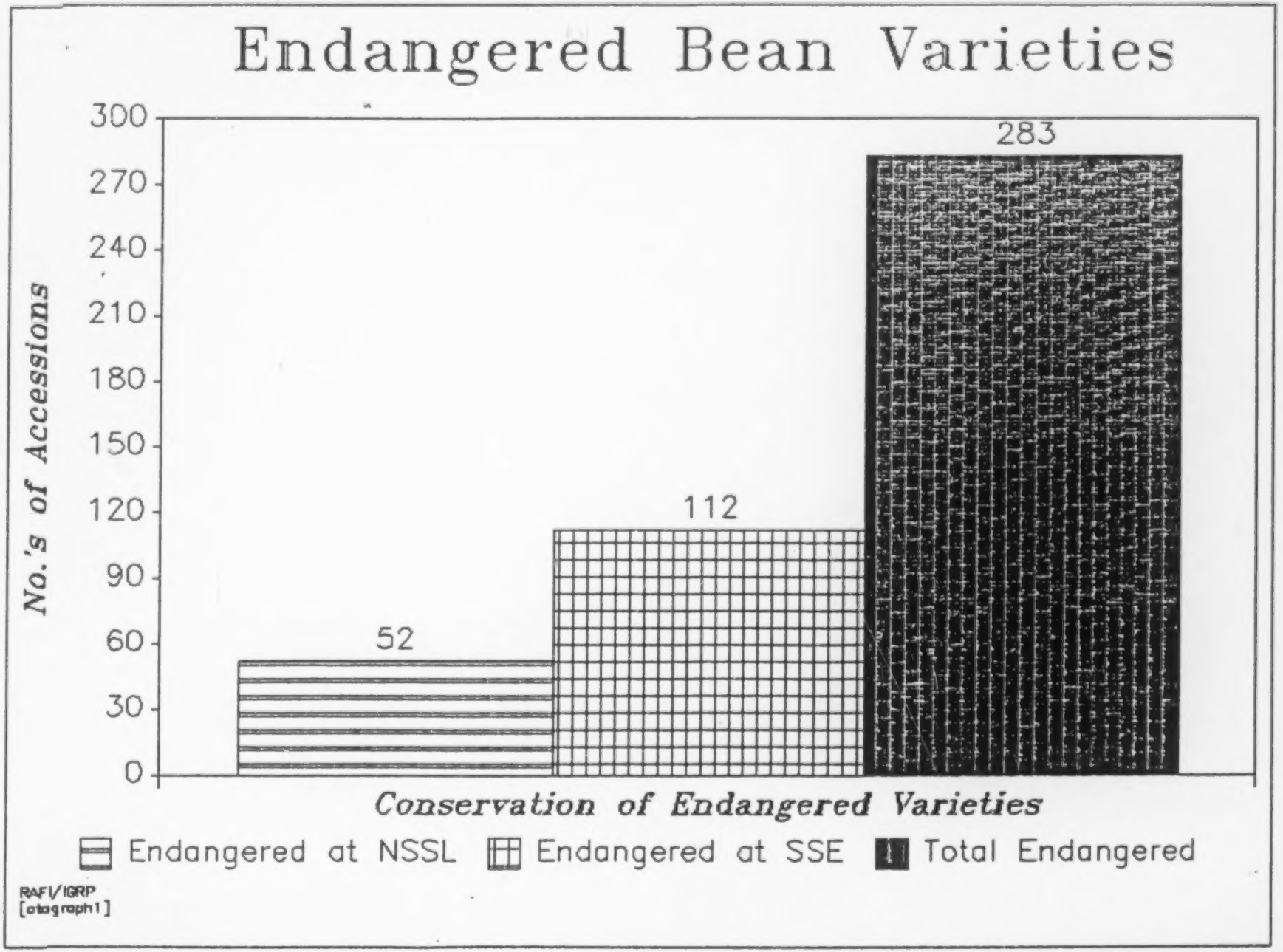
Hermann L. Suter - California

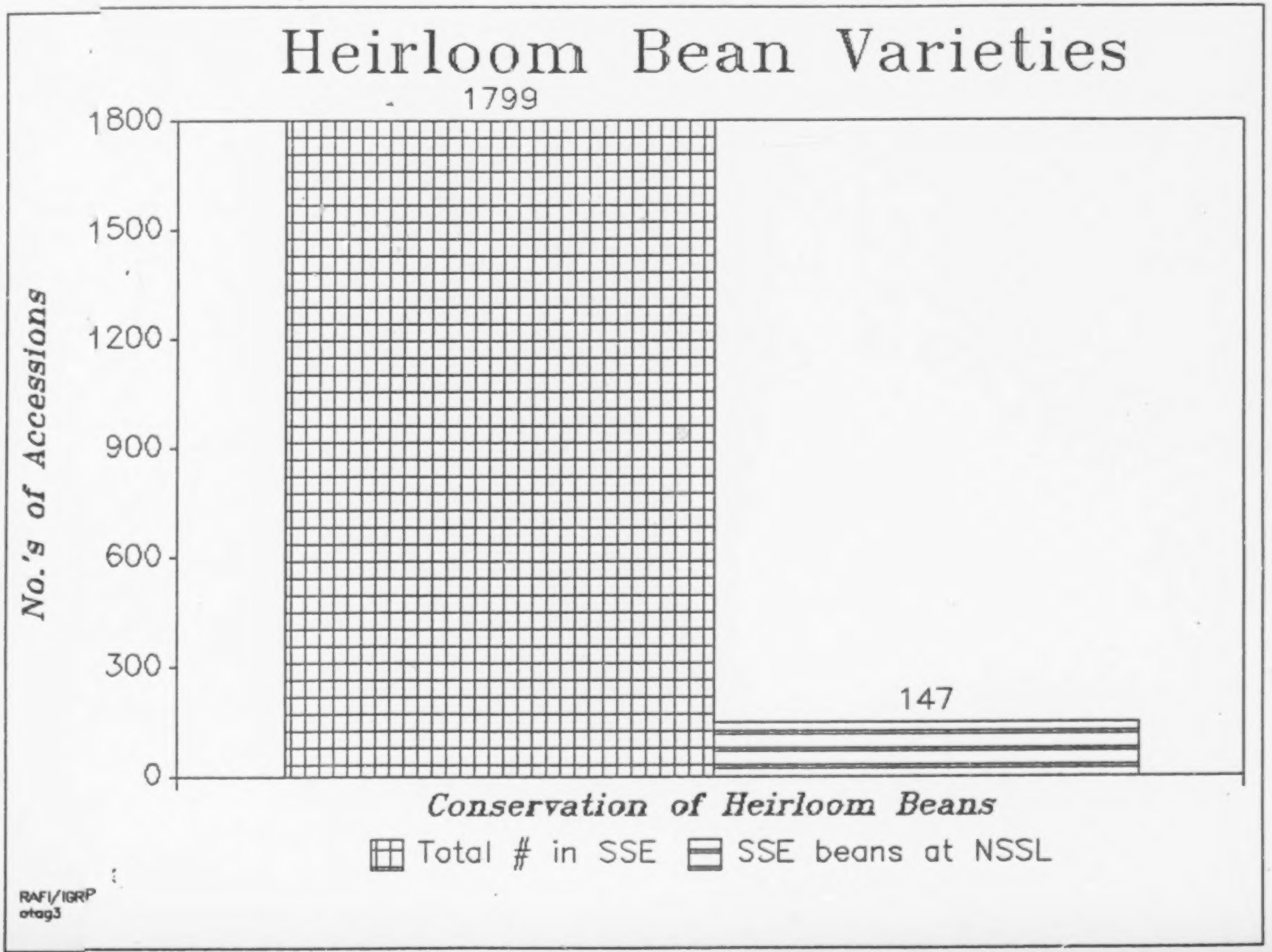
Tree Crops Nursery - California

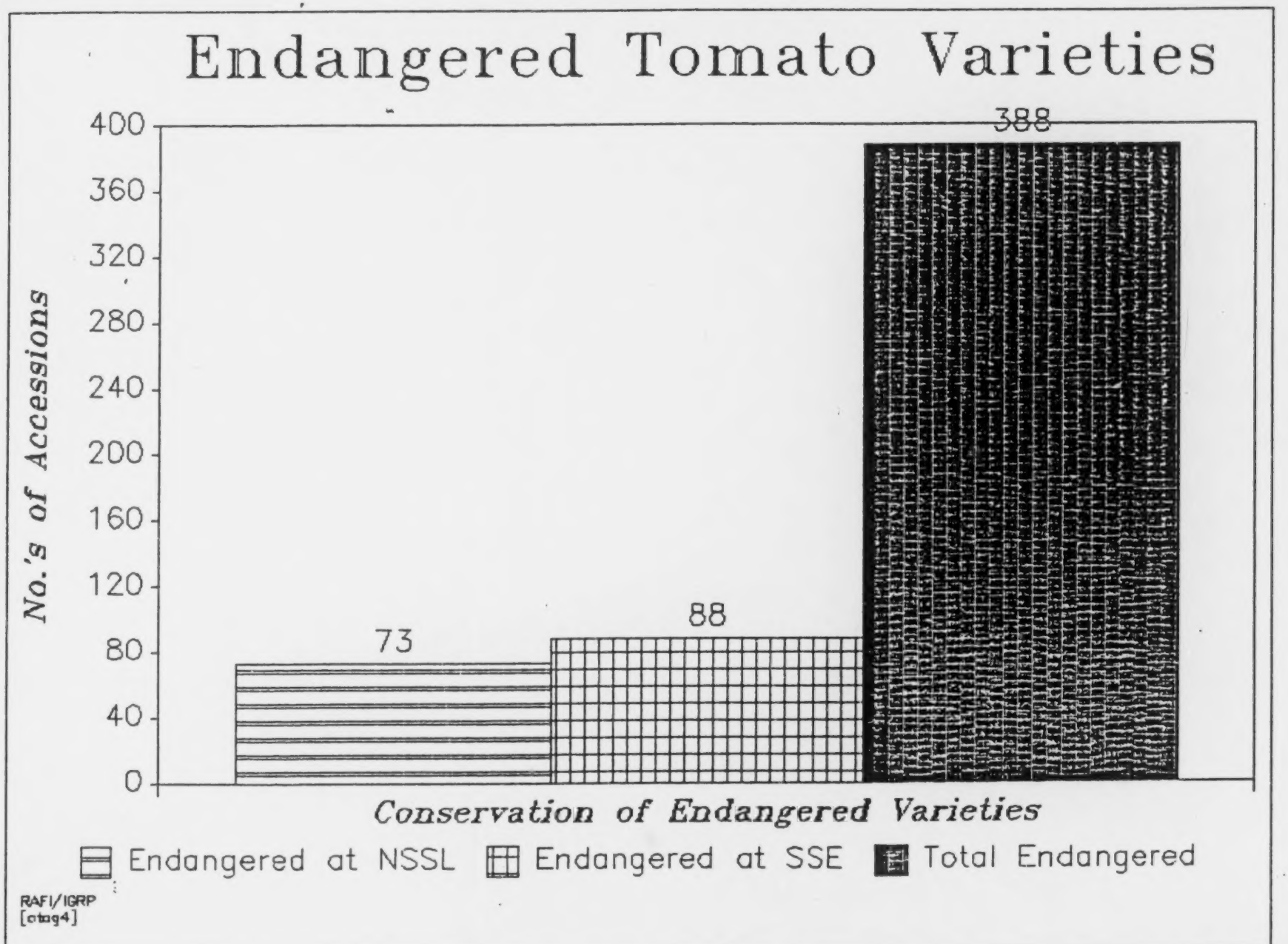
Waynesboro Nurseries - Virginia

Leslie H. Wilmoth - Kentucky

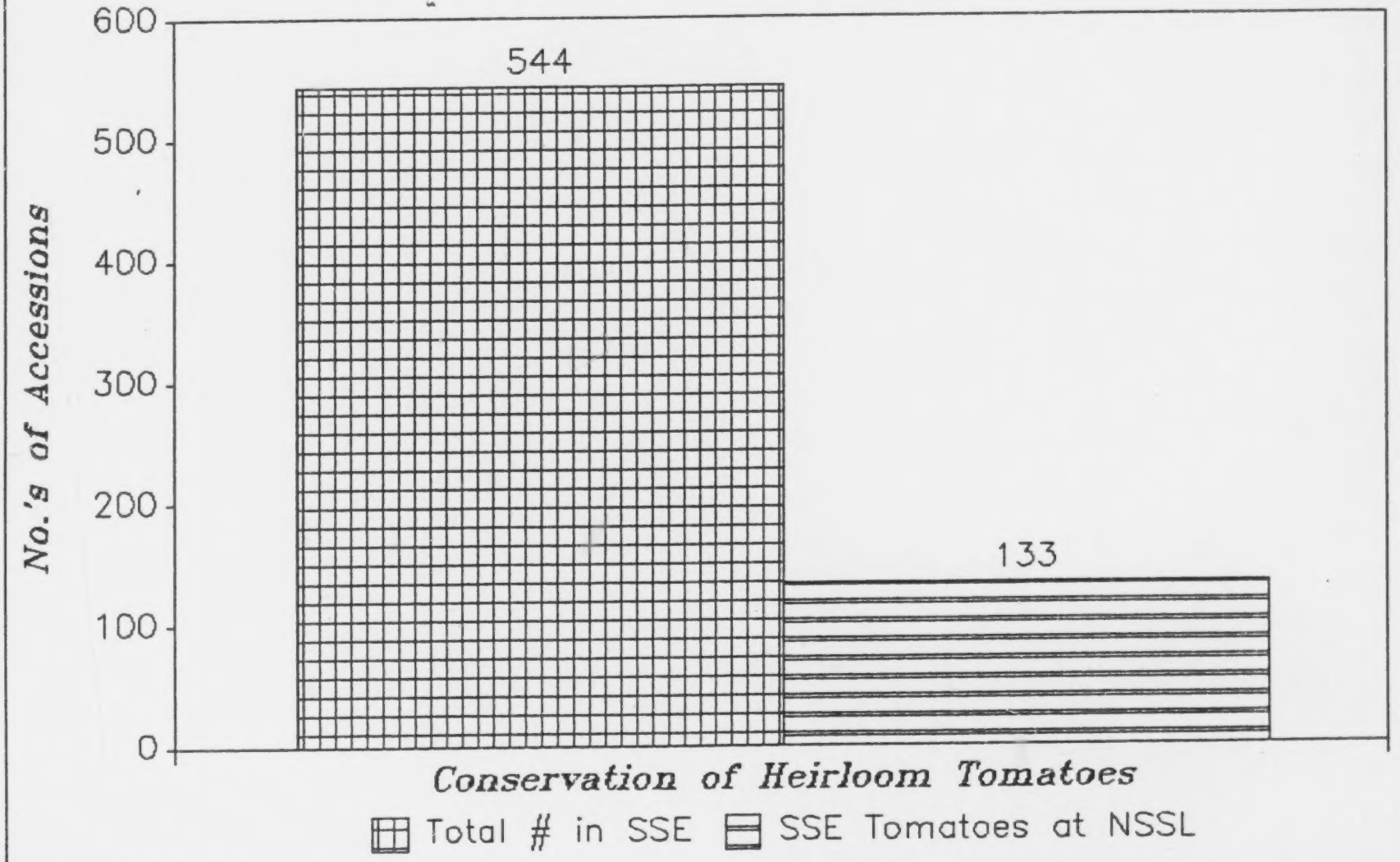
Wolf River Nurseries - New York


Endangered Bean Varieties
300
270
240
210
180
150
120
90
60
30
0
No.'s of Accessions
283
112
52
Conservation of Endangered Varieties
Endangered at NSSL
Endangered at SSE
Total Endangered
RAFI/IGRP
[otagraph1]


Heirloom Bean Varieties
1799
147
1800
1500
1200
900
600
300
0
No.'s of Accessions
Conservation of Heirloom Beans
Total # in SSE
SSE beans at NSSL
RAFI/IGRP
otag3


Endangered Tomato Varieties
400
360
320
280
240
200
160
120
80
40
0
No.'s of Accessions
73
88
388
Conservation of Endangered Varieties
Endangered at NSSL
Endangered at SSE
Total Endangered
RAFI/IGRP
[otag4]

Heirloom Tomato Varieties



RAFI/IGRP
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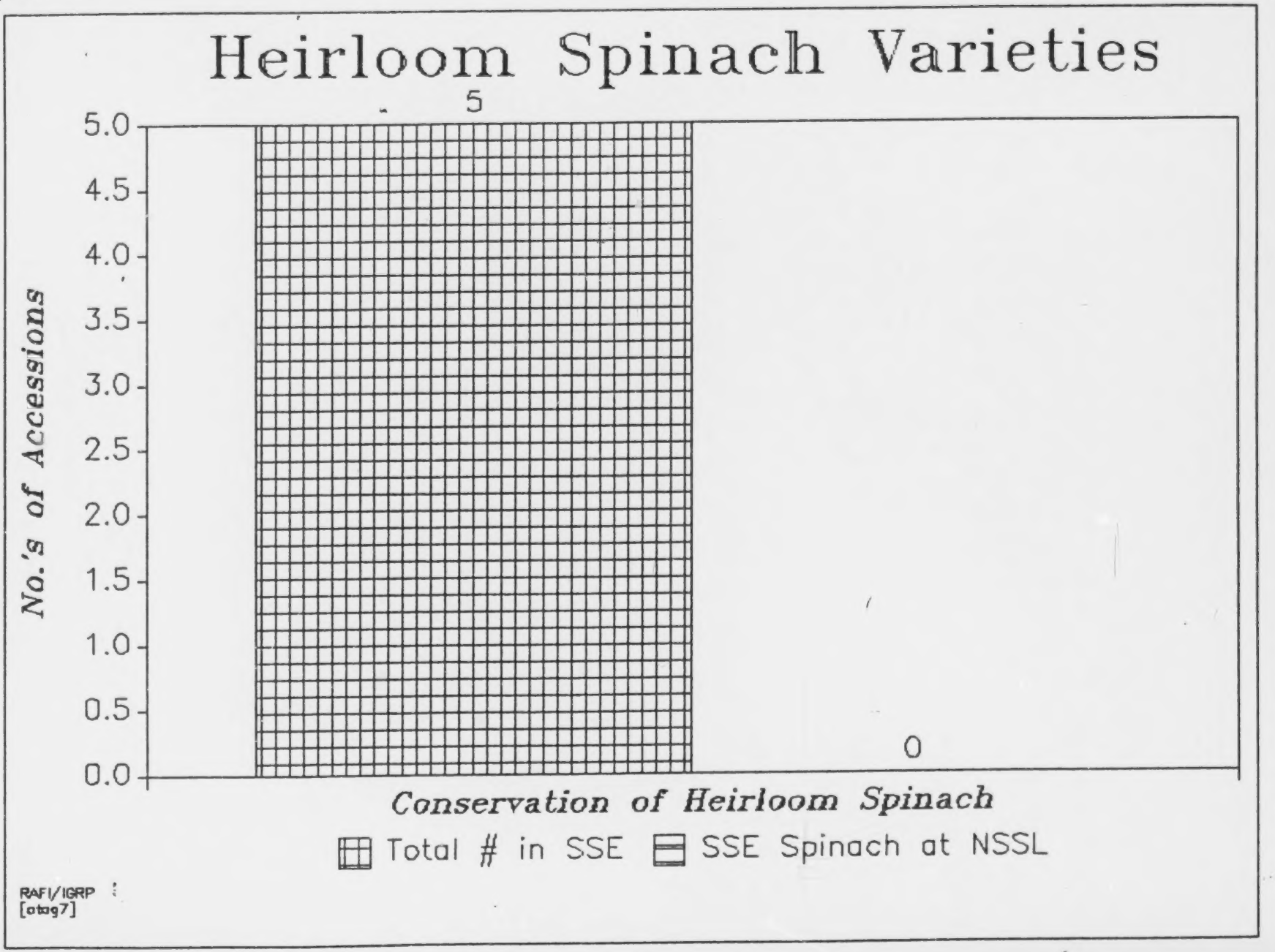
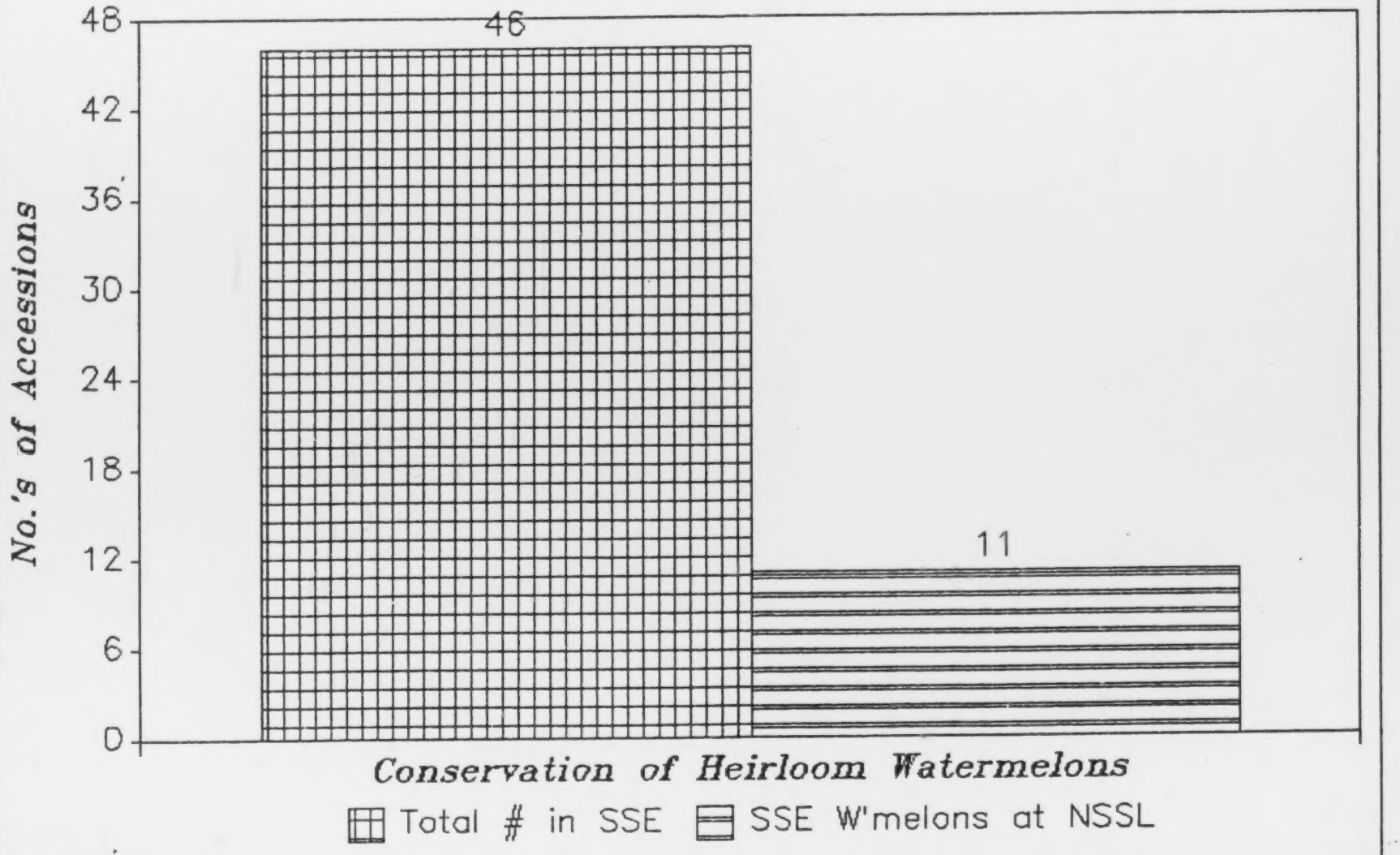
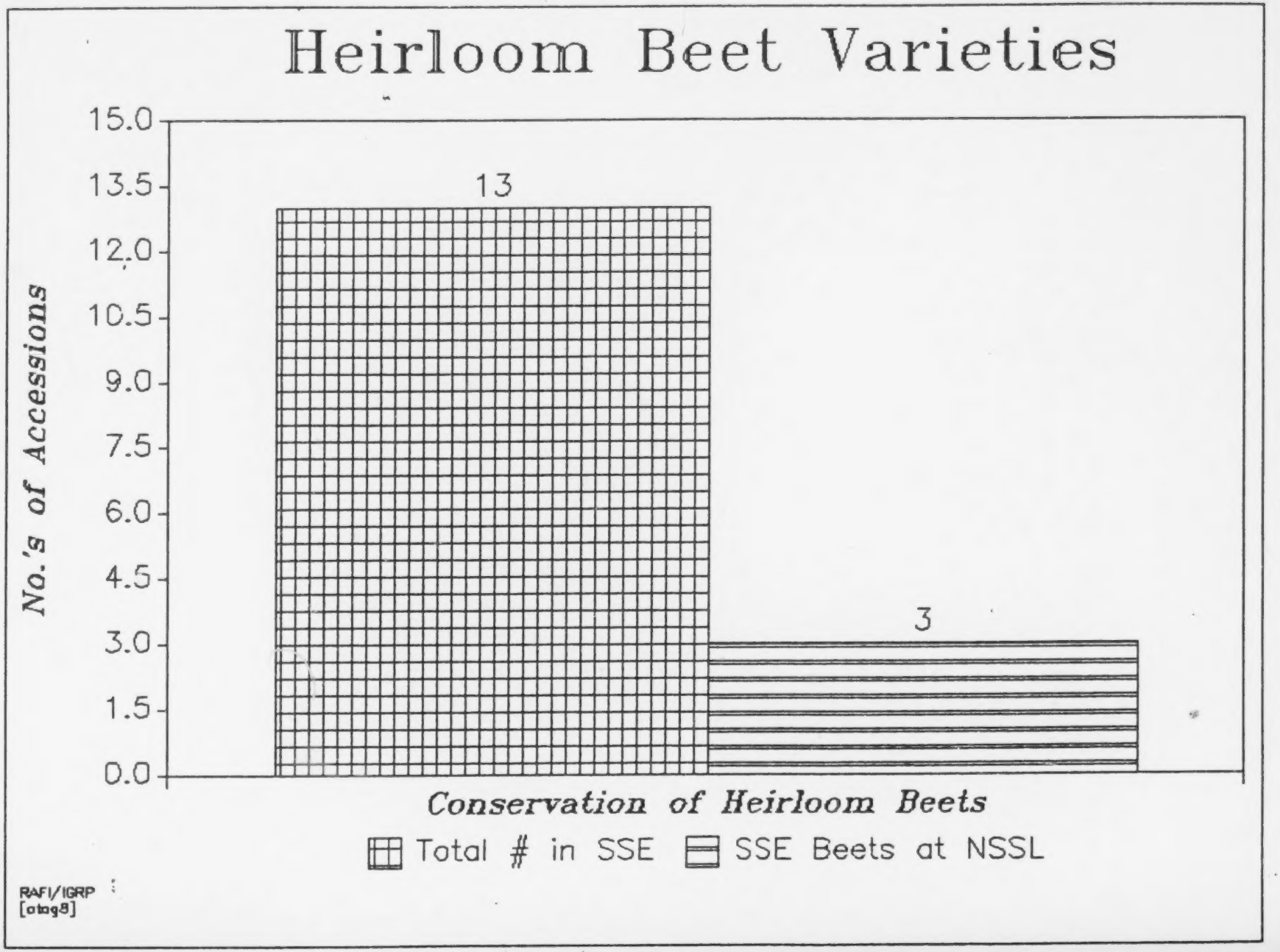
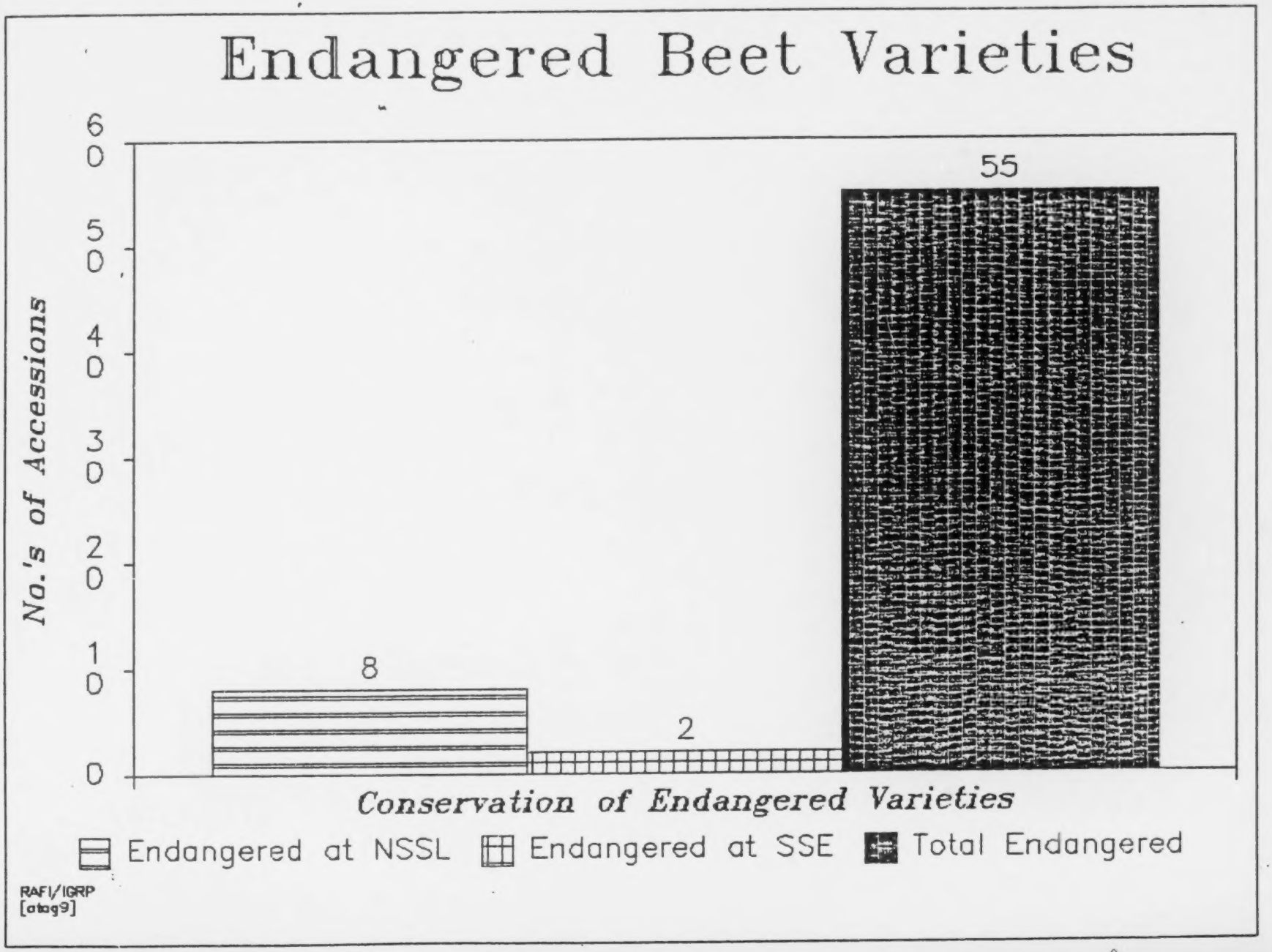

Heirloom Spinach Varieties
5
0
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
No.'s of Accessions
Conservation of Heirloom Spinach
Total # in SSE
SSE Spinach at NSSL
RAFI/IGRP
[otag7]

Heirloom Watermelon Varieties

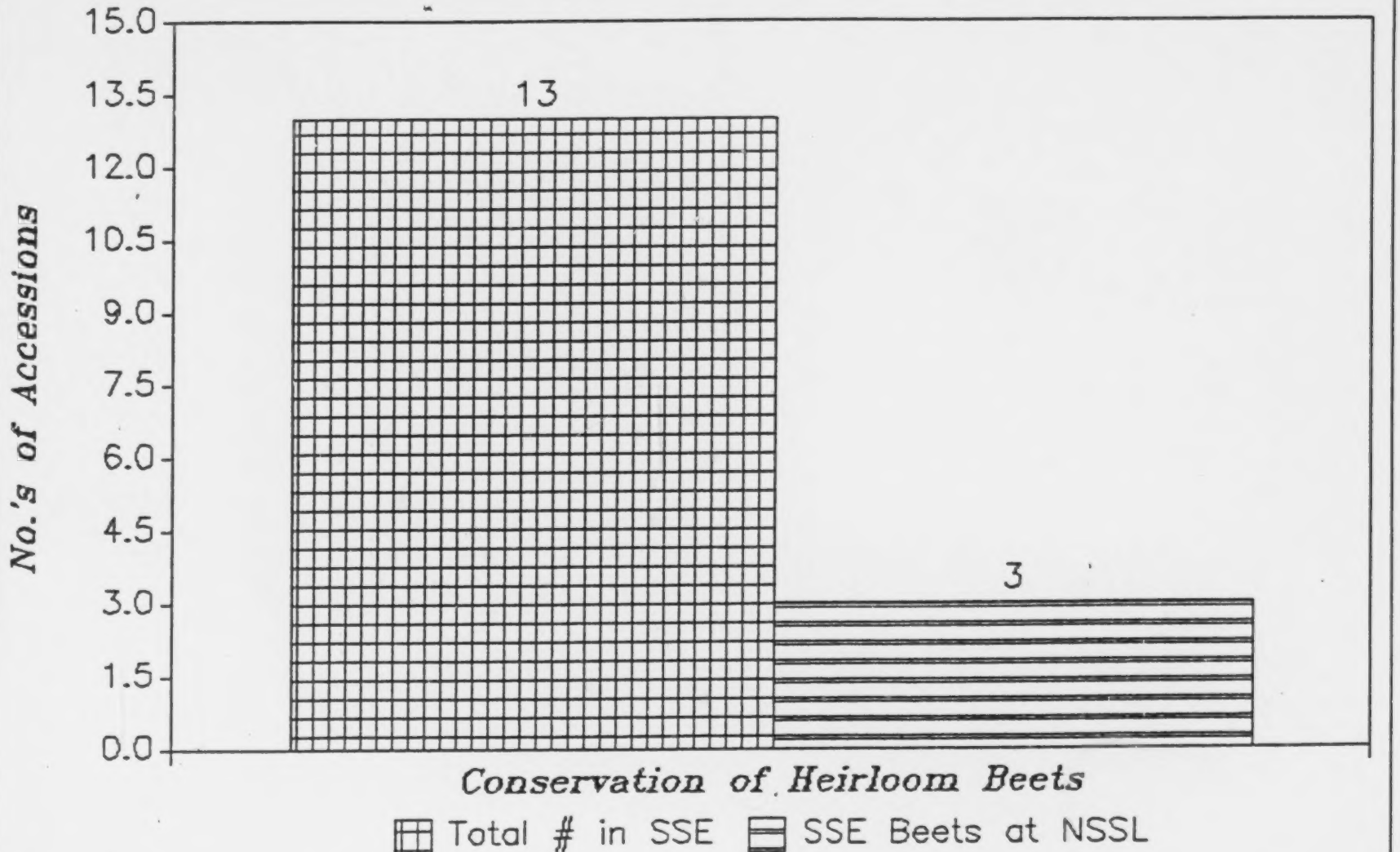


RAFI/IGRP
[otag6]

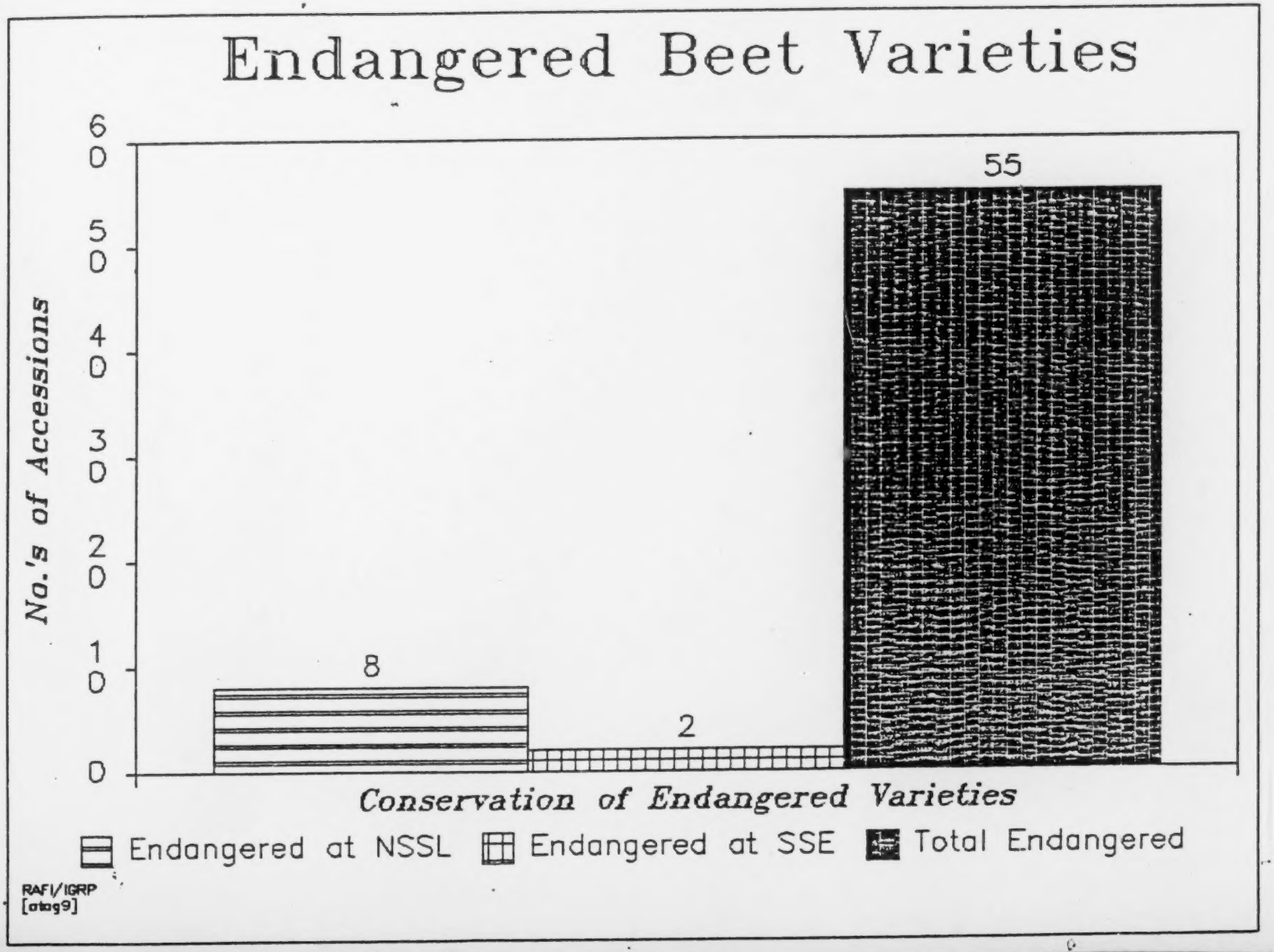

Heirloom Beet Varieties
15.0
13.5
12.0
10.5
9.0
7.5
6.0
4.5
3.0
1.5
0.0
No.'s of Accessions
13
3
Conservation of Heirloom Beets
Total # in SSE
SSE Beets at NSSL
RAFI/IGRP
[otag8]


Endangered Beet Varieties
No.'s of Accessions
60
50
40
30
20
10
0
8
2
55
Conservation of Endangered Varieties
Endangered at NSSL
Endangered at SSE
Total Endangered
RAFI/IGRP
[atag9]

Heirloom Beet Varieties



RAFI/IGRP
[otag8]


Endangered Beet Varieties
No.'s of Accessions
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50
40
30
20
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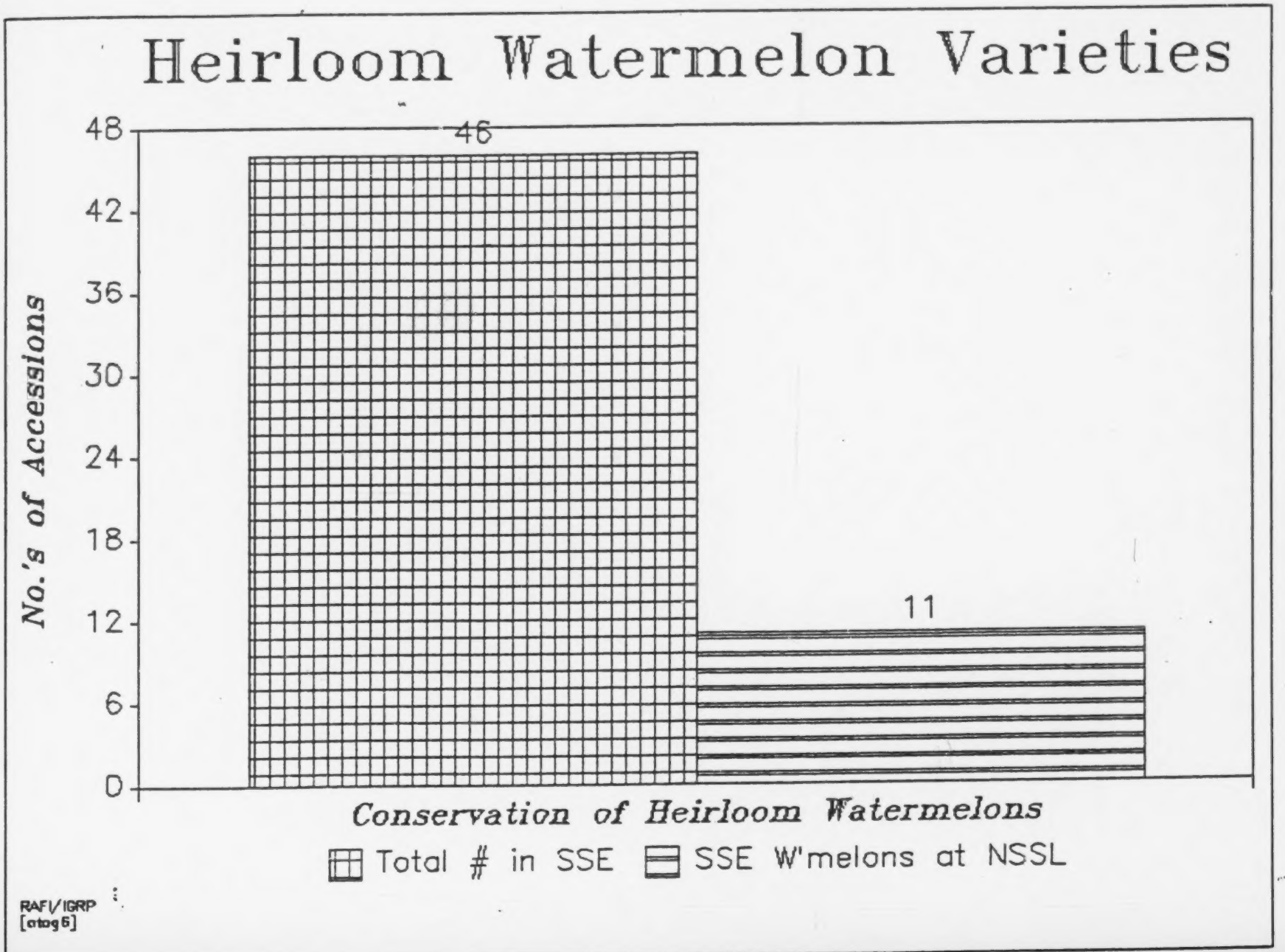
8
2
55
Conservation of Endangered Varieties
Endangered at NSSL
Endangered at SSE
Total Endangered
RAFI/IGRP
[atag9]


Heirloom Watermelon Varieties
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42
36
30
24
18
12
6
0
No.'s of Accessions
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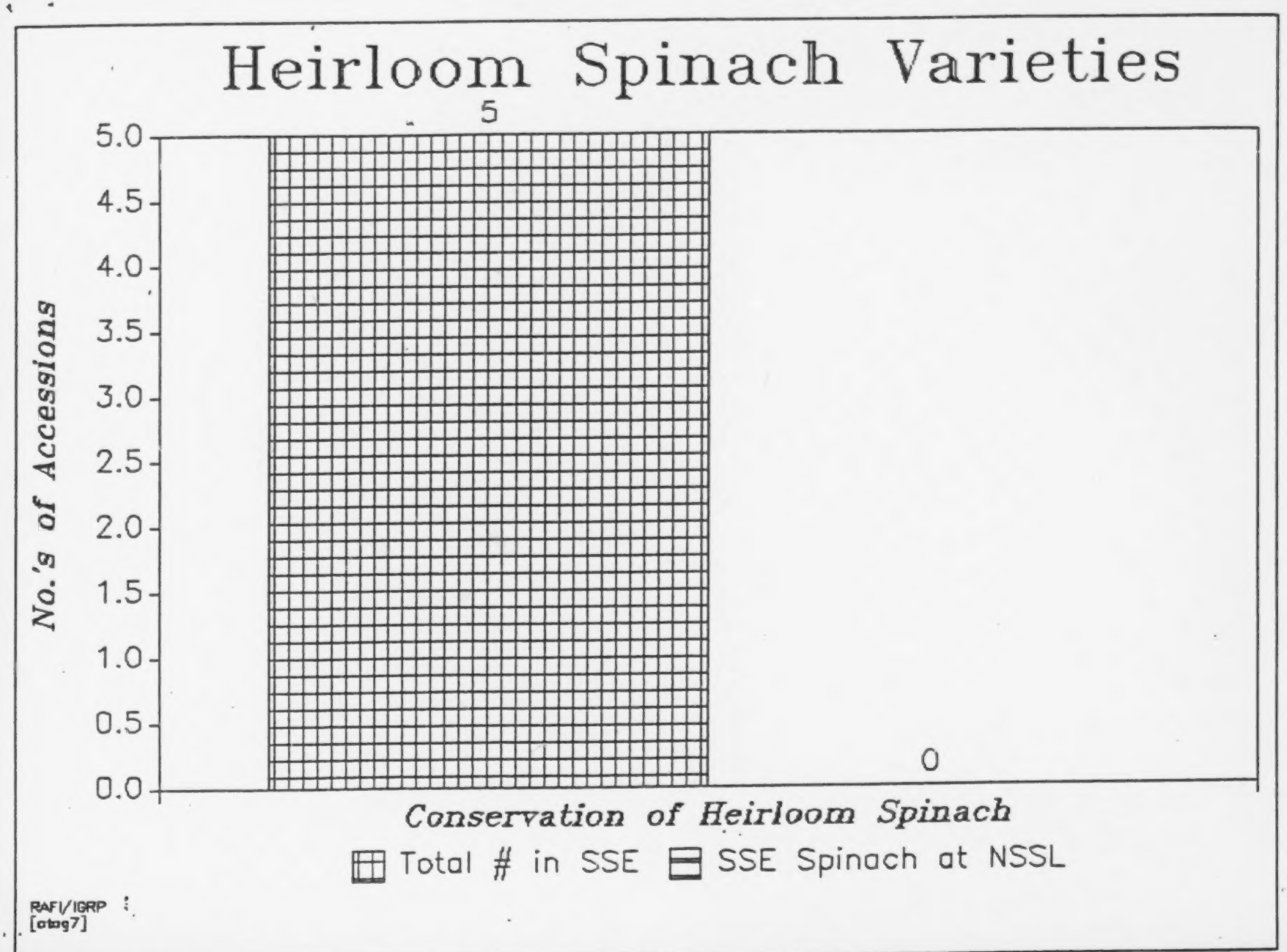
11
Conservation of Heirloom Watermelons
Total # in SSE
SSE W'melons at NSSL
RAFI/IGRP
[atag6]


Heirloom Spinach Varieties
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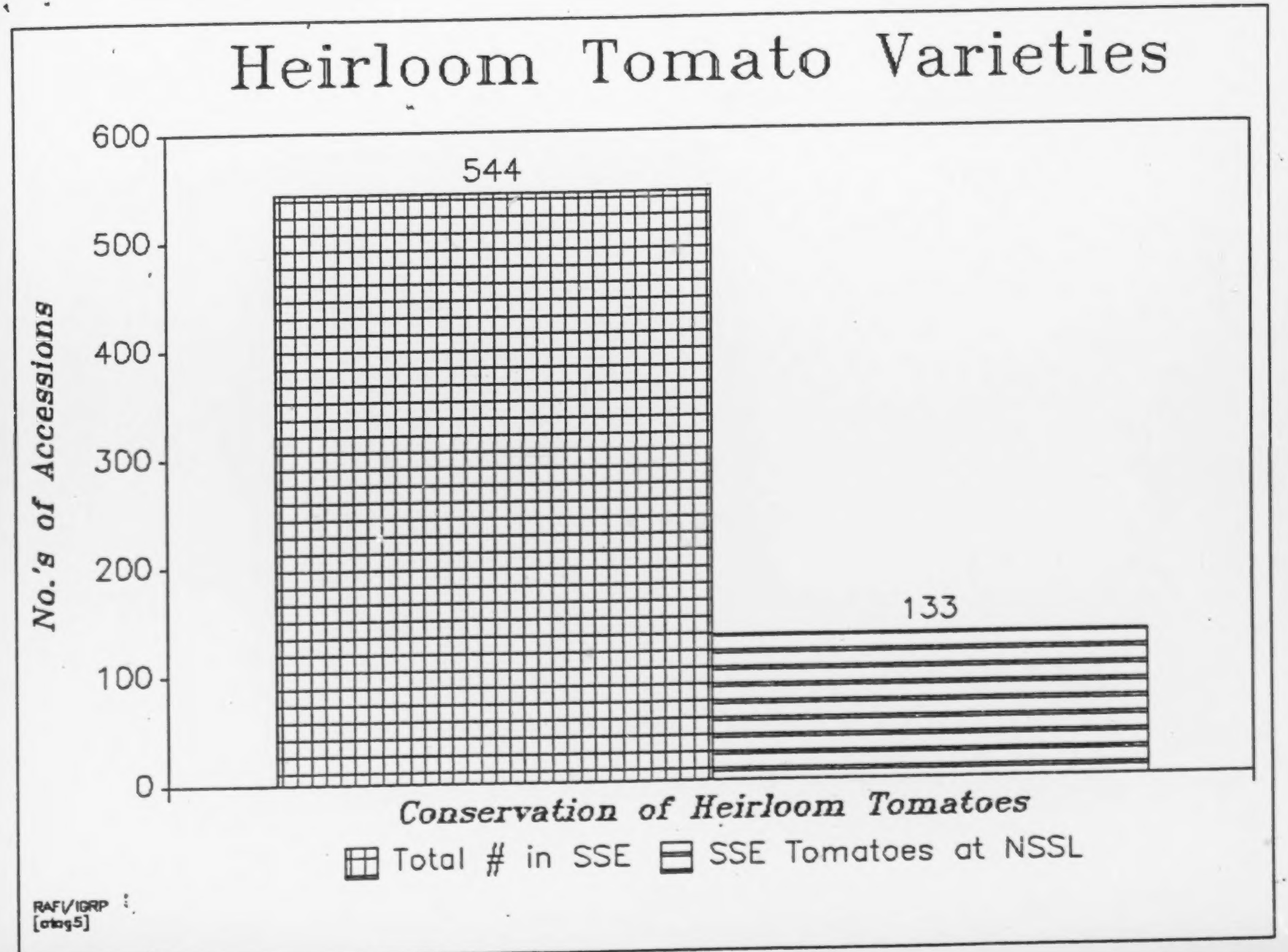
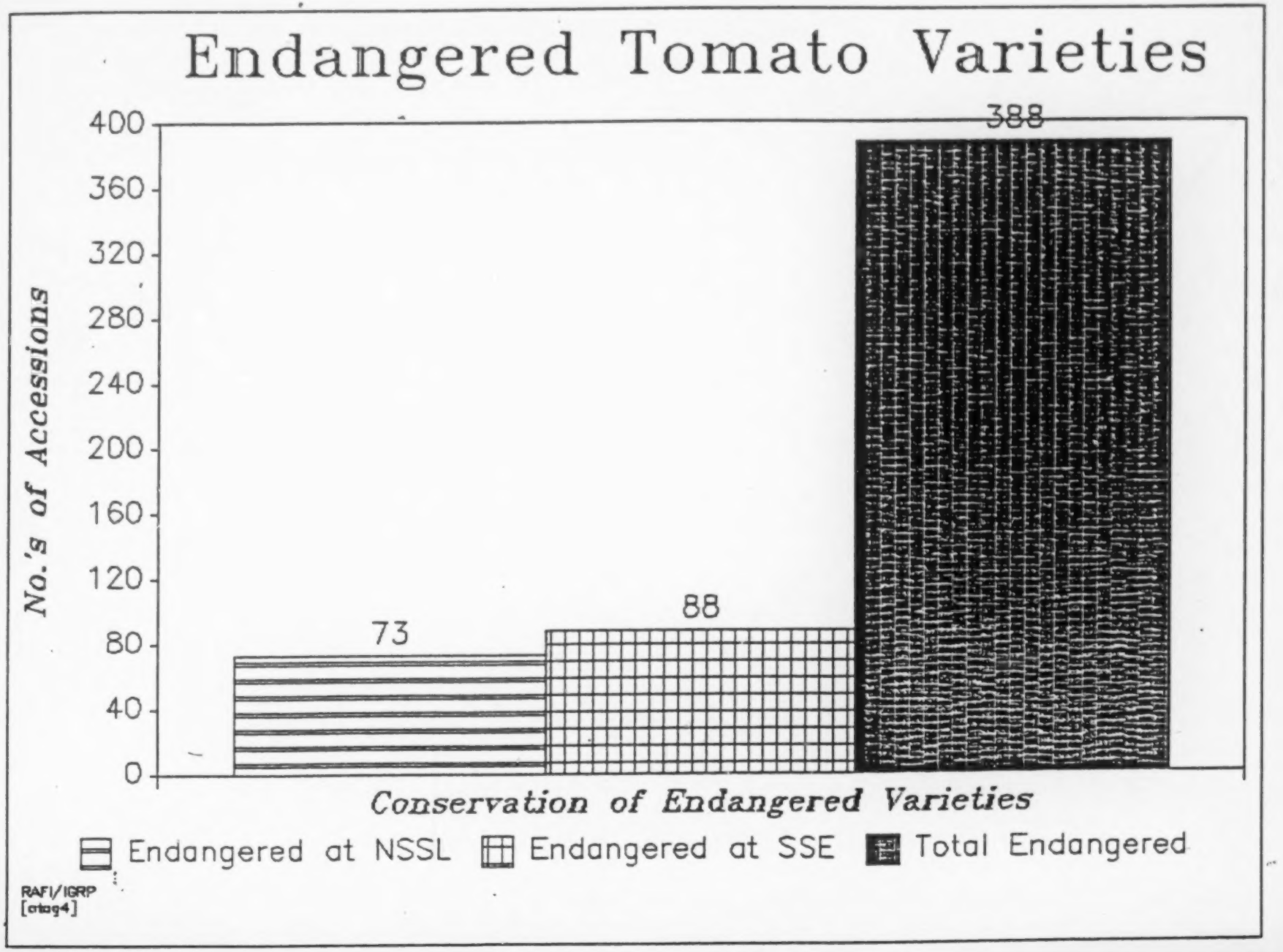
0
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
No.'s of Accessions
Conservation of Heirloom Spinach
Total # in SSE
SSE Spinach at NSSL
RAFI/IGRP
[atag7]


Heirloom Tomato Varieties
600
500
400
300
200
100
0
544
133
No.'s of Accessions
Conservation of Heirloom Tomatoes
Total # in SSE
SSE Tomatoes at NSSL
RAF/IGRP
[otag5]


Endangered Tomato Varieties
400
360
320
280
240
200
160
120
80
40
0
No.'s of Accessions
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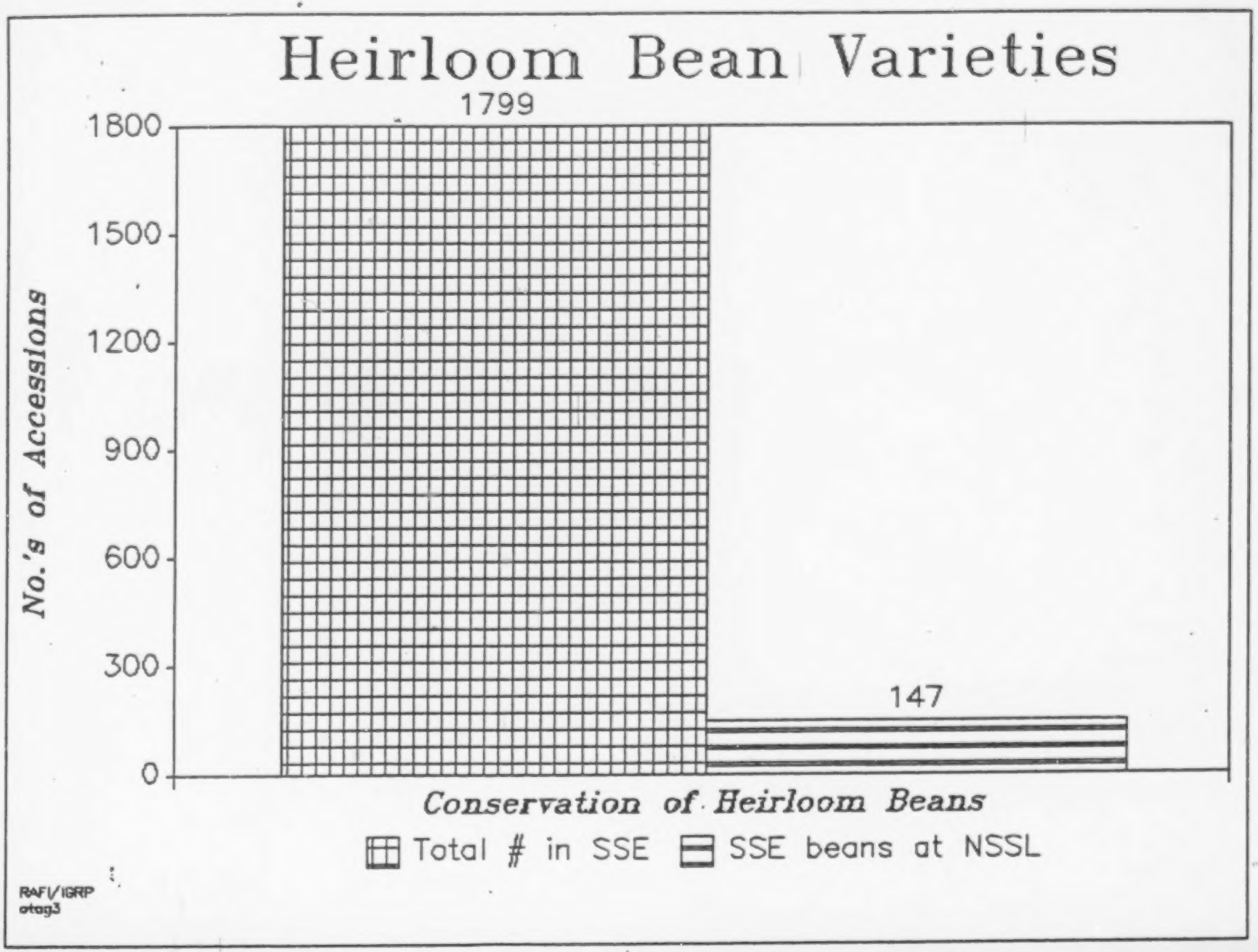
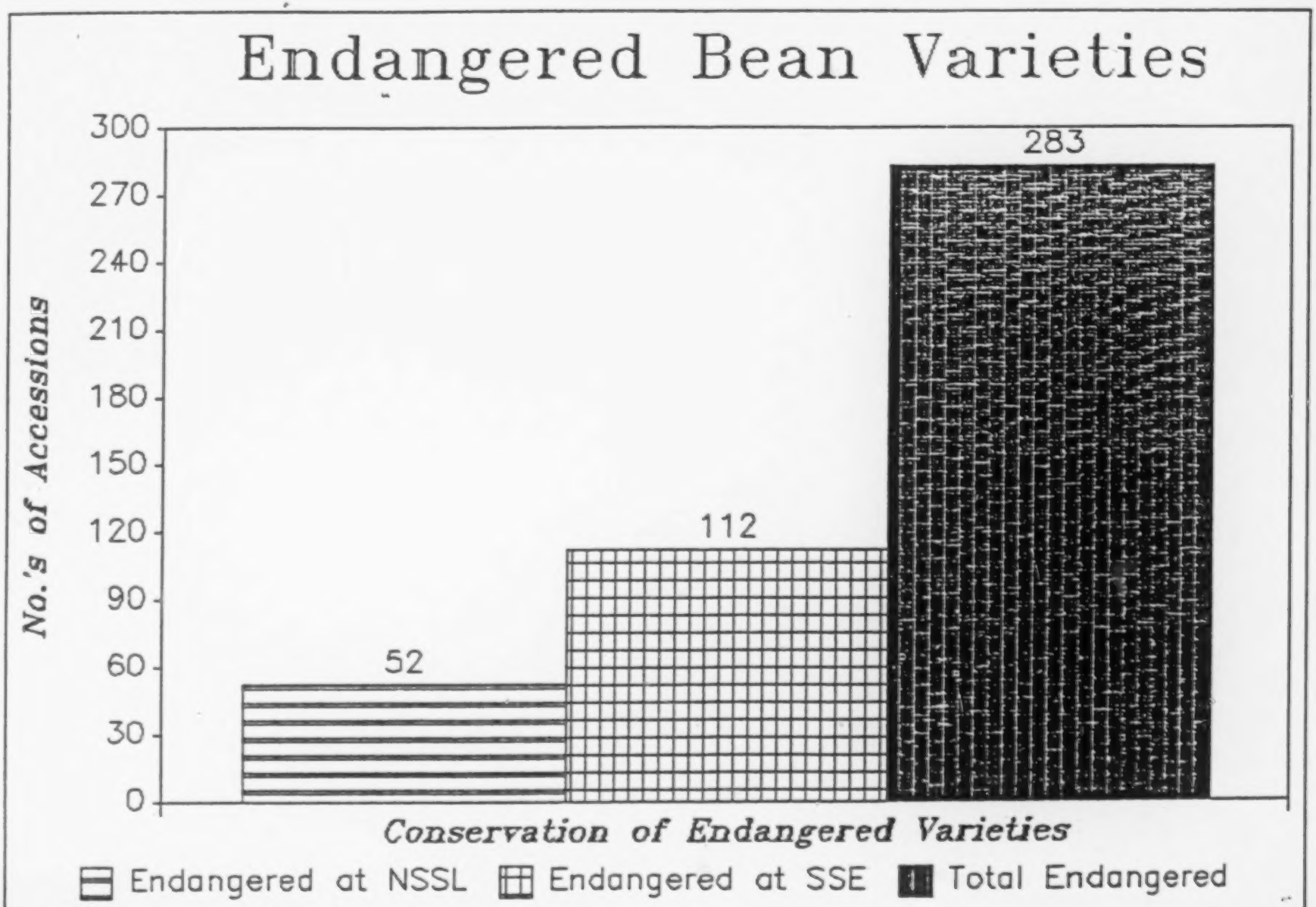
88
388
Conservation of Endangered Varieties
Endangered at NSSL
Endangered at SSE
Total Endangered
RAFI/IGRP
[otag4]


Heirloom Bean Varieties
1799
147
1800
1500
1200
900
600
300
0
No.'s of Accessions
Conservation of Heirloom Beans
Total # in SSE
SSE beans at NSSL
RAF/IGRP
otag3


Endangered Bean Varieties
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270
240
210
180
150
120
90
60
30
0
No.'s of Accessions
283
112
52
Conservation of Endangered Varieties
Endangered at NSSL
Endangered at SSE
Total Endangered
RAFV/IGRP
[otograph1]

Contract Paper No. 3

An Assessment of the Conservation of Animal Genetic Diversity at the Grassroot Level

Elizabeth Henson
American Minor Breeds Conservancy

October 1985

Office of Technology Assessment
U.S. Congress

This contract paper was prepared for the assessment of "Technologies to Maintain Biological Diversity." The views expressed are those of the author(s) and not necessarily those of OTA.

OCT 18 1985

An Assessment of the conservation of animal genetic diversity at the grassroot level.

by

Elizabeth L. Henson.

October 1985.

Abstract

The establishment of a program in the United States to coordinate the maintenance of animal genetic resources is in the national interest. All current programs are aparently from the grass root level with little or no federal encouragement or support.

An assessment is made of the contribution to actual maintenance of live populations being made by universities, private companies and individuals and the basis and stability of their contribution. Living history farms are found to be ineffective at present but have a great potential in terms of promoting the concept of minor breed conservation to the public. The basis and involvement of the breed associations is found to be primarily opposed to the maintenance of diversity but secondarily effective in that role. The condition of feral stocks and the need for their evaluation and monitoring in the United States is briefly discussed. The role and effectiveness of zoological parks and wildlife ranches in the maintenance of exotic species in the long-term program of species survival is considered along with their contribution to education and to raising the awareness of the American people to the plight of endangered species. Finally, the role and effectiveness of the various network organizations is considered along with their need to become stronger and better developed.

Contents

Introduction . . . . . 2.
Federal activity . . . . . 2.
University . . . . . 4.
Private Companies. . . . . 6.
Individuals . . . . . 9.
Living History Farms . . . . .17.
Breed Associations . . . . . .21.
Feral Livestock . . . . . .23.
Zoological Parks . . . . . .26.
Wildlife Ranches . . . . . .31.
Network Organisations. . . . .33.
Summary and Tabulation . . . .36.
Glossary of abbreviations . .38.
Bibliography . . . . . .39.

Introduction

The importance of conserving animal genetic diversity as an insurance policy for the future has been well documented and has become a topic for international concern. The purpose of this paper is to review the activities at the grass root level in the United States of America for the conservation of animal genetic diversity, and to suggest how that activity is complimented or inhibited by the policies and actions of federal agencies.

Federal Activity

The United States sponsors a number of international projects and activities that directly or indirectly help conserve biological diversity and possesses the expertise, program, planning and management capacity needed to carry out more effective international conservation (Interagency Task Force 1985). However, in order for the United States to be accepted as an international leader in this area it needs to take and support actions at home and abroad which actually conserve biological diversity (Stoel, 1985).

According to the conclusions of the USDA Council for Agricultural Science and Technology (CAST) report, the establishment of a program in the United States to coordinate the management of animal germplasm resources would be in the national interest (CAST, 1984). The United States House of Representative committees on agriculture, merchant marine and fisheries, science and technology and foreign affairs, and the Senate committees on agriculture and foreign relations

have expressed their support for the concept of developing conservation strategies for animal genetic resources (De La Garza, 1984; Jones et al, 1984; Fuqua, 1984; Fascell, 1984; Helms, 1984; Pell, 1984). The methods, reasons and International examples of these programs are now very numerous with over 700 references in a bibliography recently produced on this subject (Westby, 1985). Despite this and the request of the FAO in 1980 for more information from the three major world areas from which they had no minority breed domestic animal information,the USA, USSR and China, only the second two have indicated their willingness to cooperate in creating an inventory of their breeds as a preamble to conservation programs (FAO 1983). This leaves the USA lagging far behind many developed countries and even some developing countries in its concern and activity for animal genetic resource conservation.

In the absence of any form of reply to enquiries for current information for this paper from the USDA National Germplasm Conservation Coordinator, and in the absence of any animal equivalent to the National Plant Germplasm Resources Board (NBPGR), it is apparent that no active animal conservation programs have yet been developed at the Federal level.

The U.S. Fish and Wildlife Service (USFWS) and National Science Foundation (NSF) have programmatic interests that relate to the preservation and study of stocks of endangered breeds. Some federal lands could well be used to meet these needs. The vast acreage of lands currently held in the U.S.

Department of Energy's (D.O.E.) National Environment Research Park, might for example provide an invaluable resourse of this type. Domestic sheep are currently grazed on the D.O.E's Idaho National Engineering Laboratory lands and feral horses range on their Nevada Test Site. This suggests that both these sites have appropriate range habitats where rare breeds of sheep and horses could be preserved respectively (Brisban, 1985).

USDA extension service agents, reflecting the general policy of the USDA, are concerned primarily with the improvement of food production on a national scale. They are, therefore, trained to promote modern breeds and management techniques and do not encourage the maintenance of old style or unusual breeds (AMBC,1985).

It therefore currently rests with grass root activity to ensure the survival of animal biological diversity in the United States.

Universities

University animal and veterinary science departments frequently maintain small breeding populations of livestock for experimentation and teaching. A recent survey showed that, with a few noteable exceptions, these were normally of common breeds (AMBC, 1985).

Specifically the Louisiana State University (LSU) Animal Science Department is interested and involved in maintaining Lousiana Native Sheep as a pool of genetic variation, and for research into their physiology and resistance to foot rot (Humes,1982). Similarly, Utah State University (USU) has a

very active program to collect, maintain and study "old type" Navajo sheep. This is a multihorned breed adapted to survive in the harsh environment of the Navajo reservation and has a fleece type essential to the weaving culture of the Navajos (McNeal,1980).

A number of university groups have expressed an interest in the concept of rare breed conservation and evaluation, for example, the University of Georgia, which is already working with feral stocks on Ossabaw Island (AMBC,1985). In order to ultimately determine which breeds should be conserved in the long term, and which breeds carry genes of possible immediate use, their evaluation in a range of environmental and dietary conditions is needed. Funding specifically for this is not currently available. Even the established LSU, USU and Georgia projects are under constant threat from budget limitations.

Dr. Somes of the University of Connecticut has made a substantial contribution to the conservation of poultry through the production of an international registry of poultry genetic stocks. This is annually updated and acts as an important catalogue of the existing resources (Somes, 1984).

In conclusion, university animal science, genetics and zoology departments should be eligible to receive funding and be encouraged to take an active part in specific minor breed conservation and evaluation projects,in order to make these breeds available to animal breeders and genetic manipulators in the future.

Private Companies

There are basically two groups of companies involved in the conservation of biological diversity by maintaining stocks. The first are those directly involved in animal breeding and therefore requiring genetic diversity themselves, while the others have no direct involvement in the use of animals.

Of the former the most important are the poultry, and to a lesser extent pig improvement companies. The poultry industry is very well developed and centered around a very few highly productive stocks, derived in the United States and both maintained and distributed by a small number of companies. There are only nine world class primary breeders of chicken broilers and nine primary breeders of egg layers supplying most of the industrial sector. Three primary breeders currently provide most of the world's turkey poults and one of those has over half the world market (Crawford, 1983). It is further speculated by poultry geneticists that many of the grandparent lines used by these breeders have identical or similar origins. The resultant high level of uniformity is found to be on an international scale both in the developed and in many of the developing countries (Somes,1981)

These companies are dependent upon new sources of genetic variation in order for their improvement programs to continue. Their intensive selection is already resulting in a situation where they have homozygous and inbred birds with the maximum genetic production possible using the genes already at their disposal. They are extremely competetive and for that reason are very secretive about what conservation

stocks they hold and very protective of those stocks, which are, therefore, not available to other breeders in the private or business sector. They plan their breeding programs approximately ten years in advance and hope to be self-sufficient in genetic variation for that period. Meanwhile they are actively seeking additional genetic resources outside the company although as their influence on the poultry industry increases this will be more and more difficult to find (Crawford, 1983).

Besides the eventual cessation of breed improvement as a result of the disappearance of new variation in poultry strains, it has already been shown in plants that monotypic populations become vulnerable to epidemic disease. Similar uniformity and consequent vulnerability is becoming evident in commercial poultry breeding (Crawford,1983; CAST,1984).

Several commercial swine breeding companies are supplying an increasing proportion of breeding stocks in the pig industry. Once again this crosses international boundaries and coupled with intensive parallel selection for intensively fed, housed, lean pigs, is dramatically reducing strains which may be resistant to disease, able to thrive out of doors and survive on low quality diets. Commercial companies currently obtain their genetic variation from within the industry.

Finally, the artificial insemination (AI) companies in the dairy industry could be involved in the maintenance of cattle genetic variation in the form of frozen bull semen. This method of conservation is well documented and practiced in

many countries (Maijala,1984; Smith,1977; Smith, 1984). Some United States companies have already expressed an interest in the concept and do already hold some small conservation stocks (AMBC, 1985). They are, however, commercial operations and with no guideline from the USDA. They cannot be expected to devote time and facilities to a conservation strategy from which they will probably not profit and on which their competitors are not spending money (Crawford, 1983).

Of the comoanies not involved in commercial animal breeding the most famous involved with rare breed conservation is undoubtedly that of the Busch, Budweiser Clydesdales. August.A.Busch Jr., son of the head of one of the nations leading breweries, was already an accomplished horseman in 1933. At that time, just prior to the repeal of prohibitior, he realized the tremendous advertising value of a hitch of Clydesdale horses and proceeded to purchase two.

To celebrate the end of prohibition one hitch was sent to deliver the first case of beer to the White House, while the other went to New York to Governor Al Smith, who had worked for the repeal. This began a series of very popular coast to coast promotional campaigns in the United States. A breeding program was established in 1940 with the continuous importation of top quality stock from Scotland and Canada, and Mr Busch became a leading and very influential breeder (Brown, 1979).

The whole story is a marvellous example of what can be done to help promote a company and its product while also helping

to maintain a breed. There are many other similar examples of companies maintaining farms with unusual stocks of animals as a public relations project. It is rare, however, to find the level of personal commitment needed for a long term program to be sustained.

These companies could be encouraged to take a more active part in planned survival programs for individual breeds along the lines of the American Association of Zoological Parks and Aquariums (AAZPA) species survival plans (see section on zoological Parks). They could, for example, guarantee a long-term commitment of the companies' farm land and resources to a structured program in return for some form of tax concession.

Individuals

Individuals involved in the conservation of minor breeds fall into five major catergories: old-fashioned breeders, producers, conservationists, hobby breeders and fanciers.

Old-fashioned breeder

Although agriculture has been developing very rapidly in the past twenty years there are still people farming in the traditional way with the breeds of livestock they have always used. These people are in effect maintaining an invaluable national resource, often without realizing it and normally with no encouragement or support. They, or their widows and heirs, are likely to be advised by USDA agents to upgrade their stock by replacement or crossbreeding to the modern more productive strains. Since the inception of the AMBC census in April 1985 over a dozen farmers have been

located who have maintained very old and rare strains of livestock which they believe to be the last of their kind. In several cases AMBC was able to put them in touch with others using the same breed in adjacent states, and with potential new breeders.

A good example of these were a number of Mulefoot hog breeders, most notably Mr R. M. Holliday from Louisiana, Missouri. The Mulefoot is a large (male weight 600 lbs) normally black, hairy pig with prick ears and the unique characteristic of a single fused toe on each foot, rather than the normal cloven hoof. There were a series of suggested origins for the breed but by 1910 there were 235 breeders registered in 22 states of America by two separate Mulefoot Hog Associations. They were a good outdoor forage breed but did not do well under intensive confinement management with a high protein diet, so that their numbers dwindled. Today there is really only one major breeder remaining.

Mr R. M. Holliday can still recall his own grandfather's herd of Mulefoot hogs which was maintained in the family for 75 years, but he was not foolish or sentimental about the breed himself. As a young man he tried out all the modern commercial and well known breeds to see how best to ensure his own livelihood. Finally he returned to Mulefoots in the early 1960's and bought registered stock from Mr Dennison who was still running the old Association and Register from Knoxville, Iowa. Within two years Mr Dennison had died and his stock had been slaughtered. Mrs Dennison continued to register pigs for the Hollidays until her death some eight years ago, when sadly all the register and Breed Association papers were destroyed.

For the past twenty five years Holliday has reared over 300 market pigs a year from his sows which live out of doors on forage and some manufactured feed. He keeps his own breeding records and a number of unrelated boars for his own use. Until recently he would sell breeding stock to any interested farmers, but has now decided that he cannot afford to continue to do this. In order to sell pigs over the State line there are requirements for veterinary certification and other paper work which cost in the order of $50 per pig, and takes time that Holliday does not have. Besides this the out-of-State buyers are invariably not prepared to pay any more than regular market price for their hogs. Holliday has therefore been forced to restrict his operations to the production of pigs for the local meat market.

Holliday is now 68 years old and still runs four small farms with very little help, despite a serious problem with his spine. He has no sons and his only daughter, who lives on the farm, has married an electrical engineer.

The Hollidays are determined that the breed should survive, and that it has a lot to offer. Besides a good temperament, good mothering ability and the attributes which have suited it to an outdoor existence, the "mulefoot" itself might be an answer to the problem of splaying feet of confinement hogs which spend their entire lives on concrete.

Despite the determination of this man and the characteristics the breed has to offer, extinction is still a very real threat.

Generally the old fashioned breeders of many breeds are dwindling in number, and their breeds are disappearing with them, under commercial pressure and USDA recommendation. In the absence of a strong network, and recognition, they will eventually disappear completely.

Producers

Old-fashioned farmers still need to make their living from their livestock, but the producer category represents people who have purposely begun to keep minor breeds in order to supply a specialist market of products from that breed.

Among these are the Angora goat and rabbit growers who are involved in producing very specialized fibers, and colored wool growers, involved in the production of fibers for the specialist hand-spinner and weaver market. The recent upsurge in dairy goat breeding is in response to a growing demand for the production of goats' milk products for the health and anti-allergy market. Finally there are individual breed specialists whose primary aim is conservation but who are developing specialized products to help them to keep their breed. John Wheelock of Colchester, VT, for example, has a herd of Milking Devon cattle and is planning to develop a clotted Devon cream market. This would help him to make more money per pint of milk produced to compensate for the lower milk yields obtainable from this breed (AMBC,1985).

Generally, if a specialist production niche can be found for a breed there will be a reduction in the rate of genetic loss. However, in the case of Angora goats the primary genetic base was extremely narrow, making the current appearance of large numbers deceptive in terms of the

availability of variation within the breed. (CAST,1984). Selection for milk production in dairy goats will ultimately result in the reduction of genetic variation.

Colored wool growers are not normally interested in conservation but in the fleece of individual animals. They could, however, be encouraged to become involved in pure-bred colored breeds as have similar groups in England where they have been important supporters of the Rare Breeds Survival Trust(RBST).

Conservationists

There are a small number of people in the United States who are committed to the concept of rare breed conservation per se and are prepared to maintain rare stocks even in the face of reduced income. The King ranch in Texas maintained a herd of Wild White Park cattle which were evacuated from Britain during the second world war, entirely as a conservation exercise. Those cattle have now been dispersed. Many of the Milking Devon breeders continue to keep this very old dual purpose strain, now extinct in Britain and down to less than three hundred head in America, simply because they believe very strongly in the concept of breed conservation as a resource for the future.

Ingrid Painter from Seattle Washington is a fine example of such a breeder. She was a hand spinner and interested in American weaving and, in particular, that of the Navajo Indians. This led her to become interested and finally purchase some old type Navajo sheep in 1974.

The 'breed' was descended from Churro type sheep introduced

by the Spanish and traded to or stolen by the Navajo's in the early 1600's. As a result of the characteristics of the Churro and selective adaptation to the extreme climatic conditions on the reservation, the sheep developed a very fine dense under-wool with a long coarse hair coat growing through it. The wool maintained the body temperature and was dense enough to keep out the sand from the dust storms and much of the rain, while the hair helped to reflect the worst of the summer sun and run off the winter rain and snow.

This type of fleece was also ideal for the production of the best Navajo rugs, which were the major source of cash income to the reservation (Painter,1985). Despite that fact extension agents in the reservation have been introducing and recommending the use of Merino, Hampshire, Suffolk and other short wool meat rams since 1883. The idea was to improve the carcass quality of the sheep produced on the reservation, and the saleability of the wool on an Anglo market. The result was that today less than 500 Old Type Navajo sheep remain in the most remote areas of the reservation, the remainder being short greasy wool producing crossbred sheep, poorly suited to the environment. There is a small conservation program for the 'Old Type Navajos'being run out of Utah State University, but otherwise the survival of the breed is dependent upon enthusiasts such as Ingrid Painter.

For 11 years Painter has been collecting good examples of the breed and selecting for the old characteristics including those of the fleece, a variety of natural colors, hardiness, good mothering ability and the documented body conformation,

besides the occurence of dramatic looking four horned rams.

Her interest and research has led her to produce a small book on the breed and as a result of a growing correspondence she has produced a regular newsletter for circulation to over 400 interested people, some of whom also keep Navajo sheep. She is frequently called upon for breeding advice and to lecture about the breed and Navajo weaving techniques.

Her personal commitment has been enormous, both in terms of time and money, but her contribution is not stable. The land around their small farm is now being developed for housing and they are under financial pressure to sell. Furthermore, she has found it so difficult to find homes for the pure Navajo lambs she rears, and so dislikes selling them for meat that in the fall of 1984 she chose not to breed her ewes at all but left them barren for the year.

She and other breeders like her have a lot to offer in terms of the conservation of old breeds, but their continued efforts are not currently being adequately monitored or encouraged.

It is vitally important that such breeders be identified and located so that their projects can be monitored, and where necessary, assisted by direct grant or tax concession. The direct recompense to farmers for the estimated loss of production incurred by maintaining unimproved stocks is already being used in several European countries. (Maijala,1984; Bodo, 1982).

Hobby breeders.

There are an increasing number of people in America who

are non-farmers with some farm land on which they would like to keep some livestock. They are not generally familiar with livestock or the maintenance of breeding programs; their interest may be short term and their flock or herd size will be small. As individuals they cannot play a very big role in breed conservation, but within the guidance of a strong national network organization serving a function similar to that of the RBST in Britain, their enthusiasm, land and resources could be used in an effective large scale program.

Fanciers

The term fancier applies to breeders who maintain and usually competitively exhibit, breeds or strains of poultry, pigeons and cavies. The area of most concern is among poultry where the commercial industry is well developed and centered upon a few large companies.

The ethic of the poultry fancier is to encourage the use of cross breeding and the conservation and perpetuation of phenotypes rather than the original genotype. Within the confines of that brief they are numerous, active and effective. One hobby supplier in the United States advertises the availability of virtually all the lesser known breeds in the American Poultry Standards of perfection, many of which are considered to have been extinct for decades. (Crawford 1983). This resynthesis is an acceptable procedure within the confines of phenotype conservation, but may be misleading in terms of availabilty of genuine genetic variation.

Fanciers exert considerable selection pressure when selecting individuals for exhibition, but regularly purchase breeding stock from other suppliers. In the absence of any

system of pedigree registration and in the light of the fact that most birds trace their ancestory back to one of only a few dealers, there is evidence of only a small genetic base within each breed. (Skinner, 1974)

Thanks to the relatively simple genetic makeup of the external characteristics of poultry the fancy breeders have maintained a very wide variety of poultry phenotypes as is their aim. There is still concern, however, that althiough the colors and shapes of the birds are maintained, the real pool of genetic resources in terms of genuine distinct populations is diminishing.

In conclusion, America is a nation of individuals and it is they who have primarily maintained variation through their own individual tastes and preferences. In order for them to continue to be successful in the face of increasing specialization in agriculture, there must be established an effective national network organization. This should be strongly supported by a federal program of research, coordination, evaluation and constant monitoring to ensure that no breeds or strains are inadvertantly mismanaged or lost. This will also involve an education program for USDA extension agents and farmers through the national farming press and should incorporate the establishment of a national semen bank with availability of all minor breed on a national scale.

Living History Farms.

The concept of living History Farms is to recreate farming, or some aspect of it as it took place at some time in the

past. It is generally agreed among administrators of these museums that livestock is the single most important factor in the successful realization of that goal (Engler.W. 1983). Despite this, many living history farms have completely avoided the use of animals due to their lack of space, financial resources and skilled personnel, while others have chosen to incorporate borrowed or leased animals for short periods during the peak visitor season. Of the 600 member museums of American Living History Farms and Agricultural Museums (ALHFAM) only 20% have livestock programs of any kind.(Engler. 1985)

In recent years, museums with livestock programs, most notably Old Sturbridge Village, MA, Colonial Williamsburg, VA, Plimoth Plantation, MA and Sleepy Hollow Restoration, NY have done extensive research into the historically accurate appearance of the livestock characteristics of the period in which their museum is set (Cook.P.1982; Finnet-Davis.J. 1976.; Kelsey.D. 1978) Some have then set about 'breeding back' programs to recreate a phenotype which most closely fits that visual image, which may involve cross breeding followed by positive selection in favour of an old phenotype.

Finally with the growing awareness of the rare breed conservation movement in Britain and Europe some individuals within the living history museum field have become actively involved in promoting the use of historically accurate pure breeds in their museums. The interest in this approach is growing but there are currently only a few sites involved in maintaining pure breeds and even then the programs are new,

dependent on the enthusiasm and skill of one or two members of staff, and on a very small scale. Colonial Williamsburg, Old Sturbridge Village, Plimoth Plantation and one or two others have made active contributions to the survival of variation within breeds by funding the collection and storage of semen from rare breed bulls.

Old Sturbridge Village has also instituted a partnership arrangement with local breeders of appropriate rare breeds, in their case Milking Devon cattle and Tamworth pigs. The farmers involved then maintain large breeding units and supply the museum with exhibition groups (Shinn,R.,1985)

Living History Farms are dependent on donations, grants and income from their visitor facilities in order to continue operating. They are independent of each other in terms of funding, management and exhibition strategy. Currently they are not contributing in a quantitative significant way to active maintenance of rare breeds of farm livestock. They could, however, play a vital role in exhibiting historically important breeds, and promoting the concept of their conservation to the general public. This idea of involving public interest in livestock conservation by way of historic farms and farm parks has already proved itself to be effective in long term programs in other parts of the world, most notably in Britain and Hungary.

In Britain, the establishment of privately owned collections of rare breeds which are open to the public as 'farm parks', has played a key role in the success of the rare breed conservation program in that country (Henson.1982.) In Hungary, the importance of tourism on the

grassland plains, 'pusta', and the role of their historic breeds in maintaining the appearance and cultural heritage of the area has been very important in supplying the State with funding to maintain the large-scale and very effective projects currently in operation (Bodo, 1982).

The problems of maintaining breeding programs within the staff limitations and budgets of individual living history museums in America is a serious one. Staff are often only short term and unskilled in the management of livestock, while many sites reduce their staff levels drastically or even completely during the off-peak closed season.

Programs which incorporate partnerships with farmers maintaining well documented pedigree flocks and herds of the apropriate rare breeds could enable museums to act as a "show case" for the conservation effort while providing some active financial support for the farmers running the breeding programs.

The development of such partnership programs could be encouraged by the active support and help of local extension agents, and by the introduction of tax incentives or grants to encourage breeders to take part in the support of museum projects to promote their breed. Help should also be given to the museums to enable them to develop their interpretation and educational materials to include the concept of rare breeds conservation.

In conclusion living history farms are not currently playing a major role in maintaining biological diversity in the

United States. Furthermore, due to their present management structure, personnel and financial arrangements, it is unlikely that they ever will. However, their potential role in raising public awareness to the need to conserve rare breeds could be easily exploited and have extremely useful long-term and far reaching effects.

Breed Associations.

Breed Associations are unions of farmers who maintain and produce the same pure breed. They act as a pedigree registration and certification service to their members and as a commercially based breed promotion and marketing service, recommending their breed in preference to any other.

In normal circumstances they seek to 'improve' their stock by encouraging selective breeding. Breed standards are set, show classes sponsored and a constant watch made of the market trends. Active selection and breed improvement, is by definition the removal of 'less desirable' genotypes from the population and, therefore, the gradual reduction of genetic variation within the breed.

The combination of these two factors, breed promotion and breed improvement are, therefore, directly opposed to the maintenance of biological diversity.

Provided every breed has some form of breed association,and that the standards and proposed selective niches for each is slightly different, breed associations do work in combination to maintain biological diversity. In some cases, however, recent common ancestory followed by parallel selection and competition between breeds for the same market, has resulted in a misleading number of "breeds" which are in effect very

similar populations. This has happened with many of the modern sheep breeds in America.

Alternatively one breed may become supreme, as in the American dairy industry where the current emphasis is on maximum whole milk production per cow on high quality feed, rather than efficiency of milk solid production. In this situation the Holstein has been able to push out many of the other dairy breeds (CAST,1984).

The associations of the declining breeds (the Jersey, Guernsey, Ayrshire and others) are fighting for their share of the market and are, therefore, inadvertently working to conserve biological diversity. The Holstein Association is gradually taking over from the other breeds, and due to an efficient sire selection and artificial insemination program are dramatically reducing the effective number of sires being used within their own breed. The total effect is to reduce the national pool of genetic variation in dairy cattle very considerably (CAST,1984)

Minor breed associations are able to keep breeders in touch with each other, keep and make available pedigree information essential to prevent serious inbreeding in small populations, and help to promote the breed in whatever way is appropriate.

Active associations are very important in ensuring that a breed can survive, but they are dependent upon member contributions, and in the case of small associations are normally member-run. It, therefore, often happens that a very small breed which really needs the support of an association

cannot sustain one (Crawford, 1982). In this situation network organizations such as the Rare Breeds Survival Trust in Britain have been very effective in assisting with basic communication and registration services until members are able to sustain their own support organization. Similarly, the American Minor Breeds Conservancy has been active in helping to reform the Milking Devon Cattle Association and beginning Lineback Cattle and Jacob Sheep Registries.

In conclusion, most breed associations do not consider the conservation of diversity to be one of their aims; however, provided at least one active association is maintained and supported for each breed, they can assist in achieving that goal.

Feral Livestock.

Feral animals are domestic stocks which have escaped from or been released by man and have subsequently re-established themselves in the wild as breeding groups. In the case of most feral stocks in North America, they are exotic, non-indigenous species. They often reside in habitats in which they have not evolved balanced relationships with predators and food supplies. Over population often occurs, increasing the likelihood that they may pose a threat to natural environments. This is particularly true in the case of offshore islands, where endemic flora and fauna are often ill-adapted to survive the competition and or predation of introduced stock. Feral stock may also compete with local farmers and indigenous game animals and generally belong to

whomever owns the land on which they live. They are, therefore, often a State or even Federal problem.

In terms of biological diversity these stocks represent 'samples' of the livestock populations from which they originally came. Strong natural selection to survive in their feral niche has caused them to develop along quite separate lines to their continuously domestic cousins. Soay sheep of the Outer Hebridean Islands of Scotland have survived in this way as a living remnant of populations of sheep our ancestors farmed two thousand years ago (Jewel, 1974). As such they have genetic characteristics quite different to any remaining in our modern breeds, and are of great interest and possible use. Feral animals are an intermediate between wild and domestic animals and, as such, constitute a particularly important potential source of genetic variation (Mason, 1982).

Feral populations in the USA have on the whole been poorly studied with no general survey since 1964 (McKnight, 1964). At that time there were estimated to be between 18,000 and 34,000 feral horses, commonly interbreeding with domestic stocks. It is general policy in most States to eliminate them (McKnight, 1964).

Burros or Donkeys were once very important and common in the US and are successful as feral animals. There were estimated to be between 5,500 and 13,000 in semi desert regions (McKnight, 1964). Numbers were being reduced in all

states other than California in which there was a conservation program on nostalgic grounds.

Cattle generally make poor feral stocks while sheep and goats tend to be unsuccessful unless they are protected from their natural predators. The most interesting populations, therefore, tend to be on Islands. Cattle, sheep and goat feral stocks can still be found in Hawaii dating from 1793. In the case of the sheep and goats, they have been a serious problem in term of erosion and habitat destruction, but are important hunting animals and are currently controlled. The cattle stocks on Hawaii have all but been wiped out.

There are also feral cattle on the Aleutian Islands off Alaska. Modern sheep populations from around 1940, and old goat populations, probably of Spanish origin are on the islands off the coast of California.

Finally hogs are the most numerous feral stocks in America, mostly in the south-east and south-west where they are found in the hundreds of thousands (McKnight, 1964). This stems largely from the traditional way of free ranging pigs in the Southern states. They are dramatically different from pigs found in modern confinement operations and concern has occasionally been expressed that they may act as a reservoir of disease. However, given their lifestyle, survival rate, and total lack of any medication, it seems more likely that they could act as a pool of genetically controlled natural immunity to disease.

Intensive studies of the feral hogs of Ossabaw Island, GA for example, have shown them to be physiologically and biochemically unique. They are naturally mildly diabetic, and have unique fat handling biochemistry which makes them valuable in programs concerned with human diabetes and obesity. On the same island, introduced white tail deer were found to carry a unique sickle cell anemia, making them also useful medical research animals. (Brisbin,1980). This clearly shows how genetically different and valuable feral stocks can be, and how dangerous is their indiscriminate destruction without study.

Clearly, when feral stocks of exotic, nonindigenous animals are destroying the local ecology they must be removed but can be subsequently managed and evaluated elsewhere.

In conclusion, feral livestock has the potential to carry biological diversity not found in domestic or foreign stocks. Their survival is precarious and dependent upon the owner of the land on which they live, which is often the State or Federal government. It is essential that their numbers, conditions, descriptions and possible contributions be documented and monitored in order that this resource should not be lost and that efforts be coordinated at the various levels of government involved.

Zoological Parks.

Historically, zoological parks have been involved in exhibiting wild animals to the general public in an

entertaining and later educational way. In more recent years the emphasis has shifted more towards general education and raising the awareness of zoo visitors to the plight of each species in the wild which has led in turn to the exhibition of animals in more natural surroundings and the involvement of more zoos in breeding programs for their captive exhibits.

Within the last 10 to 15 years the plight of many species in the wild and the ever growing threat of extinction has awakened zoos to their possible role as "last chance" sanctuaries for the survival of many wild species destined for extinction in the wild and as a source of maintained breeding units with which to repopulate natural habitats.

The New York Zoological Society's Bronx Zoological Park is a good example of a zoo which has lived through this transition from concrete cages with bars, using animals to amuse the New York public, to their current involvement with large ecologically more accurate exhibits and an effective conservation-based interpretation and education program.

This approach is now widespread among zoos and is coming to be expected by the zoo visiting public. The Bronx zoo may however, be considered to be advanced in its breeding program with the aid of its breeding sanctuary, the St. Catherine's Island Survival Center, off the coast of Georgia, where breeding units can be maintained. The San Diego Zoo has a similar wild animal breeding center separated from the main zoo facility and steps are being taken to include some wildlife ranches as breeding centers in order to increase the total land area available to the zoo breeding programs and

thereby the number of species with which they can effectively work.

There is considerable variation between zoos in terms of their size (the average in North America is less than 55 acres) and in terms of their private or institutional status and funding. Generally, the physical and financial resources of zoos are limited, which, in conjuction with their historical basis in entertainment, has resulted in a serious bias in the distribution of the endangered species. Of approximately 31,000 specimens of live mammals in the ISIS computer based inventory of North American zoos, 82% were ungulates,(hoofed animals), primates and carnivores, and of the 5,640 carnivors, 2,000 were large felids (Foose 1982). This extreme bias clearly represents the visitor attraction of these particular animals, but may also reflect those groups of large mammals most difficult to preserve in situ.

Zoo breeding programs have, until recently, been largely confined to individual zoos and have tended to accentuate the bias such that animals which were easy to breed in captivity have become numerous or have been put onto birth control programs thereby resulting in a steadily aging nonbreeding zoo population. This is currently the case with tigers in North American zoos. At the other extreme, species which do not breed easily in captivity have in some cases continued to be dependent upon importation from the wild while many depend upon supplies from the few sites where there are successful breeding programs. This has reduced the effective gene pool

within the zoo population and the ultimate expected survival time of the species (Foose 1982)

Currently the American Association of Zoological Parks and Aquariums (AAZPA) is involved in launching and maintaining its Species Survival Plan (SSP) for a growing number of wild animal species. The SSP recognize the limitation on zoo resources in terms of space and finance and have selected species according to criteria that reflect the guidelines of the World Conservation Strategy and the objectives of the International Union for the Conservation of Nature (IUCN) and the World Wildlife Fund (WWF) (IUCN 1980).

The SSP currently includes 37 species and requires the full cooperation of all the participating zoos. It involves the maintenance of a minimum captive population of several hundred animals maintained in a closely regulated age and sex structure with the age of breeding and the choice of mates determined by qualified experts in the field of population genetics, who advise on the breeding program. This will involve close cooperation between zoos and may require the regular harvesting or removal of a proportion of the population on a regular basis (Foose ,1983). This harvesting, although essential to the success of the project in terms of long term species survival, will be difficult to explain to many funding organizations and zoo visitors. An extensive and very well planned education program, with respect to this surplus, and the need for harvesting will have to be put into operation if the SSP is to succeed.

Research within zoos into the ecological and behavioral aspects of the animals is essential if long-term management programs and considerable manipulation of breeding units is to succeed. The continued development of reproductive technologies is also needed. The collection and use of semen is already practiced in many zoos for a number of animal species; however, reliable freezing techniques need to be developed both for semen and ultimately embryos. Such technologies could, if available, enable smaller populations of live animals of any one species to be maintained, thereby leaving more zoo resources for the maintenance of larger numbers of species.

The New York Zoological Society, among others, is already involved in the successful cross-species transfer of embryos, a technology which could be extremely useful in the survival of whole species or the increase of rare blood lines within species (AAZPA, 1981).

The development and accurate use of international stud book facilities along the lines of the ISIS computerized central data banks for all zoo species, is essential for the easy recognition of genetic drift and inbreeding problems within the international population of zoo animals.

In conclusion, zoological parks are essentially independent local institutions united under the AAZPA umbrella. They are currently involved in independent small scale breeding programs for a large number of species but are developing national SSP's aimed at the long term survival of endangered species in captivity. They should be encouraged to make full

use of all the ISIS stud book facilities already available while additional facilities must be developed for species not yet included. The area of land available to the zoo breeding programs needs to be increased, either by enabling zoological parks to acquire and fund their own breeding ranches, or by encouraging the involvement of privately-owned wildlife ranches to participate in the program (see section on wildlife ranches). The technologies of semen collection and freezing and embryo collection, freezing and cross-species implantation should be developed and made available within the confines of planned breeding programs. The already well-developed interpretation and educational programs in place in zoolological parks should be improved to prepare the visiting putlic for the new role of the zoo as a species survival center and all that that entails in terms of species manipulation and harvesting.

Wildlife Ranches.

Over the past 20 years there have been an increasing number of privately owned exotic wildlife ranches. They stem from a hunting tradition, and at the simplest level they stock and manage large numbers of indigenous game animals for hunting. This has developed into stocking with exotic deer and finally exotic antelope and other plains living species such as elephant, giraffe and rhino.

There are probably over 600 ranches in Texas alone now stocking exotic animals, but many are dealers or short-term

hobbyists. The remainder have committed themselves to maintaining and breeding between one and thirty exotic species. Their breeding aim is usually towards impressive-looking trophy heads for hunting.

The Corazon Ranch in Brackettville Texas is a good example of one of these programs, with 10,000 acres. Two thousand of those acres were set aside in 1971 for exotic species purchased from dealers. The remainder of the ranch is used for stocking and hunting indigenous species and farming Angora goats and beef cattle. The exotic collection consists of 9 or 10 major species of cloven hoofed animals including European Red Deer, Addax, Scimitar Horned Oryx and Barbary Sheep in herds of between 15 and 250 animals (Belcher, 1985). Corazon is one of over sixty ranches which are members of the Exotic Wildlife Association, an organization which seeks to ensure that its members behave in a responsible and humane way towards their animals in terms of management and harvesting (Exotic Wildlife Association, 1974).

Exotic wildlife ranches could play a very important role in the maintenance of biological diversity in the plains living animals with which they are developing management expertise. They have the space and resources to house large herds of antelope and rhino, not possible within the limits of zoo land.

In the light of this, experimental projects with the AAZAP are already going on with Grevy's Zebra, Scimitar Horned Oryx, White and Black Rhino on some selected ranches. It

remains to be seen if the facilities and commitment are sufficient to enable them to apply the kind of accurate individual recording and intensive genetic and demographic management which will be needed for them to take an effective part in a Species Survival Plan (SSP). It may also be necessary for the ranches to institutionalize in order to ensure the long term commitment vital to any serious gene pool preservation program (Foose 1985).

In conclusion, exotic wildlife ranches and private wildlife collections do currently stock and breed a wide range of animals. Many are well established and experienced in exotic wildlife management and breeding although their breeding programs are selective rather than conservation based. These ranches could be very important in the development of SSP's provided they have the ability to individually record and intensively manage breeding programs. Finally, their private status and consequent ability to abandon the program may jeopardize the long-term success of gene pool preservation programs.

Network Organizations.

Effective networks, with the help and support of the USDA, NSF, USFWS and other federal agencies are almost certain to be the key to the conservation of maximum biological diversity in animals in the United States. Unlike plants, most animal genetic resources cannot yet be stored in refrigeration and the maintenance of sufficiently large live

populations is expensive and requires land and expertise.

Networks to guide and assist individuals and companies involved in breeding rare stocks can therefore greatly assist and enhance the basic activities which should be undertaken or supported by federal agencies.

Wild animal associations such as the Exotic Wildlife Association are primarily animal welfare and member protection organizations but could be used as a means of monitoring the breeding success of its members and communicating ideas and influencing their programs.

The AAZPA is already active in the development and administration of species survival plans for zoos and wildlife ranches and should be encouraged and financed to do more.(see zoos section)

Active associations for the fancy 'phenotype' breeders have a lot of support from their membership. In particular the Society for the Preservation of Poultry Antiquities, the American Poultry Association and the American Bantam Fowl Association are very active in sponsoring shows and arranging meetings. Within the ethics of their movement they are accurate and precise and have a very large membership which is genuinely concerned for the conservation of phenotypic variation.(see section on individuals; Fanciers)

Breed associations and producer groups such as the National Colored Wool Growers Association and dairy goat associations are primarily concerned with promotion and marketing. Their combined secondary effect is, however, one of overall

conservation in terms of breed variation.(see section on Individuals; Producers)

The 4H Youth movement involving young people in farming theory and practice generally promotes modern commercial breeds and practices. However, recent communication with the USDA directors of the project's program may lead to the introduction of minor breed and breed variation oriented projects (Stormer, 1985). Although this will have little immediate effect on any one breed it will help to ensure that future generations of farmers and livestock breeders are more aware of the impotance of conserving and using genetic resources available to them.

Finally, there is only one network organization currently working in North America with the primary goal of the conservation of rare feral and domestic breeds of livestock, The American Minor Breeds Conservancy (AMBC). It was established in the late 1970's as a small membership organization run by volunteers. It has recently received funding from the CS Fund of California and the Rare Breeds Survival Foundation of America in New York, to launch a rare breed rescue project. The aim of the project is to do a national survey of minor domestic and feral breeds in America and establish a national network system for registration and referral of stock, its breeders and the research activities in minority breeds. This survey is still underway and will not, with the resources available, be exhaustive. It is hoped, however, that it can provide guidelines of areas and

breeds in the greatest need of immediate attention. It is then hoped that AMBC can act as a coordinating body for the many individuals, companies and institutions which are already or may subsequently become involved, in the same way as the Rare Breeds Survival Trust (RBST) has functioned in Britain. The RBST has been extremely successful in promoting the keeping, comparative testing, and utilization of minor breeds through a large membership, a successful annual show and sale, regular regional informational meetings and an excellent monthly magazine.

Considering the large geographical areas involved, AMBC or any similar network organization, will need the support and help of the USDA extension services and considerable public and or federal funding in order to be effective in the long term.

Summary.

In summary, there appear to be no federal programs currently in place operating to conserve animal genetic diversity, ex situ. Of the grass roots activity, zoological parks, under the umbrella of AAZPA, are probably the most stable; although their effectiveness will be limited by space, resources, and their response to public concensus. Domestic livestock programs are scattered, uncoordinated and unstable. The establishment and support of a national network organization, frozen semen and embryo banks, and a program of research and evaluation is essential if the current rate of loss of genetic diversity among domestic animals and animals with a potential domestic use is to be arrested.

Tabulation of the major groups.

Group	current activity	potential
Universities	involved with small no.s domestic rare breeds, evaluation & limited conservation programs	extensive breed evaluation
Private Co.s		
Poultry	10 yr poultry stocks	
A.I. Co.s	some cattle semen	national AI network
commercial	maintain groups of domestic breeds	more activity and involvement with SSP type programs
Individuals		
old timers	rare breeds of sheep cattle,pigs,horses	unlikely to continue
Producers	goats, colored sheep.	could increase activity and effectiveness
Conservationists	rare breeds of sheep, cattle,pigs,horses	more effective activity with coordination
Hobby	all domestic stock	some effective involvement possible with coordination
Fanciers	poultry strains	better awareness of genotype would enhance their effect
Living History Farms	ineffective breeding programs. Some historical research	more historical research, and education
Breed Associations	concerned only with individual breeds	combined effect of maintaining breeds
Zoolgical Parks	exotic species	Species Survival Plans, and education
Wildlife Ranches	domestic and exotic grazing animals	more activity possible through the AAZPA.

Glossary of abbreviations.

AAZPA	American Association of Zoological Parks and Aquariums.
AMBC	American Minor Breeds Conservancy.
AI	Artificial Insemination.
ALHFAM	Association of Living History Farms and Agricultural Museums.
CAST	Council for Agricultural Science and Technology.
DOE	Department of Energy
EWA	Exotic Wildlife Association.
FAO	Food and Agriculture Organisation of the United Nations.
IUCN	International Union for the Conservation of Nature.
ISIS	International Species Inventory System.
LSU	Louisianna State University.
NBPGR	National Board of Plant Genetic Resources.
NSF	National Science Foundation
RBST	Rare Breeds Survival Trust.
SSP	Species Survival Plan of the AAZPA.
USDA	United States Department of Agriculture.
USFWS	United States Fish and Wildlife Service.
USU	Utah State University.
WWF	World Wildlife Fund.

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Contract Paper No. 4

Grassroots Groups Concerned with In-Situ Preservation of Biological Diversity in the U.S.

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U.S. Congress

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GRASSROOTS GROUPS CONCERNED WITH IN-SITU PRESERVATION OF BIOLOGICAL DIVERSITY IN THE U.S.

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Technologies to Maintain Biological Diversity Study
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ABSTRACT

In comparison with the efforts of federal and state agencies and national conservation organizations, the role of grassroots organizations in the preservation of U.S. populations, species and ecosystems is not widely known. This paper examines the organization, programs and effectiveness of 15 grassroots groups, 5 of which are official affiliates of national organizations. The groups were chosen to represent a range of geographic areas, sizes, interests in and approaches to conservation. Grassroots groups are integral part of U.S. conservation efforts because they can accomplish some goals that government agencies and national conservation organizations cannot, although grassroots efforts cannot replace public or national private efforts. The ubiquitousness of grassroots groups diminishes the likelihood that important conservation issues will go unnoticed. Proximity to threatened species and ecosystems, and personal relationships with local officials and private citizens who can affect species and ecosystems allows grassroots groups to conserve biological diversity without having to involve national officials and conservationists. Grassroots groups can respond quickly to emergencies. Most depend heavily on enthusiasm and experience of their volunteers rather than professional training in biology, law or related fields. Grassroots education groups affect the general climate for conservation more than specific issues, and their effectiveness is therefore difficult to gauge prospectively. Grassroots advocacy groups that advise, lobby and litigate at the state and federal levels have had a major role in strengthening governments' decisions concerning species and ecosystems. Grassroots land holders use varied legal devices to preserve biological diversity; among them, affiliates of The Nature Conservancy have achieved outstanding success. Chronic lack of funds is the chief constraint on the success of these organizations.

TABLE OF CONTENTS

1 Introduction
2 Definitions
2 Grassroots Groups
2 In-situ Preservation
2 Biological Diversity
3 Acknowledgments
3 Methods
4 Organization
4 Geographic Focus
4 Primary Role
4 Educators
4 Advocates
5 Land Holders and Advisors
5 Other
5 Level of Focus on Biological Diversity
6 Proportion of Focus on Biological Diversity
6 Federal, State and Conservation Organizations With Which They Interact
6 Interviewing Method
7 Results
7 Adirondack Council
7 California Native Plant Society
8 Carolina Bird Club
8 Desert Fishes Council
8 Idaho Trappers Association
9 Iowa Conservation Education Council
9 Louisiana Wildlife Federation
9 Maine Coast Heritage Trust
10 Missouri Prairie Foundation
10 Rocky Mountain Bighorn Society (Colorado Order)
10 Tennessee Citizens for Wilderness Planning
11 The Nature Conservancy Maryland Chapter
11 Trout Unlimited New Mexico Chapter
12 West Virginia Highlands Conservancy
12 Wildlife Education Program for a Living Future
12 Discussion
13 Determinants of Success--General
14 Ubiquitousness and Proximity
15 Independence
17 Organization and Constituency
18 Affiliation and Networking
20 Effectiveness in Preserving Biological Diversity
26 Constraints on Effectiveness
27 References Cited

INTRODUCTION

Biologists have known for centuries that the spread of humankind has led to the disappearance of many animals and plants. But only in the last two decades has the American population become aware that many seemingly innocuous activities, from reclaiming "useless" swamps to fighting agricultural pests with new "miracle" chemicals, have harmful consequences for wildlife and humans alike. And it was not until the publications of Myers (1979), Lovejoy (1980), Norse and McManus (1980) and Ehrlich and Ehrlich (1981) that many members of the general public and government decisionmakers began to understand that such losses are occurring worldwide, at a dramatically accelerating rate, and at all levels of life on Earth.

Federal and state governments, often at the urging of national conservation organizations, have responded by attempting to slow or reverse such losses. They have been both successes and failures. Our nation undoubtedly would have lost far more biological diversity without efforts by the U.S. Fish and Wildlife Service, California Department of Fish and Game, Environmental Defense Fund, and similar institutions. But those who have worked at the regional, state or local level also recognize that citizen conservationists, working alone or in grassroots organizations, have also played a role in preventing the disappearance of many species and biological communities that occupied America before European colonization. Yet, because these organizations are geographically scattered and have not been examined systematically since 1977 (The Nature Conservancy, 1982), it has been difficult to gauge their importance and how their efforts affect those of governments and national conservation organizations.

In this paper, I examine a sampling of the grassroots efforts that serve to prevent loss of the biological diversity of the U.S. I concentrate on those

organizations whose focus, explicit or otherwise, is to maintain or restore native organisms and communities where they have occurred naturally.

DEFINITIONS

Some terms central to this paper have been used in various ways since concern about biological diversity became widespread. To eliminate confusion, I define three terms in the title as follows:

A) Grassroots Groups: nonprofit groups of individual citizens or organizations (coalitions) whose focus and base of support are at the local, state or regional (not national or international) levels. This includes affiliates of some national conservation organizations, such as The Nature Conservancy, National Wildlife Federation and Trout Unlimited, that exercise considerable autonomy within their national organizations. It does not include government agencies, intergovernmental coordinating councils or government-appointed advisory commissions, diploma or degree-granting educational institutions, private research institutions, nor those organizations with a national support base that focus on species or ecosystems in a specific region.

B) In-Situ Preservation: maintaining ecosystems or populations of species within their natural ranges in something approaching their pristine condition, or restoring them towards their pristine condition within their original geographic boundaries after damage or depletion. This means not only maintaining or restoring numbers of individuals of a species or numbers of species in a community, but also conserving the population structure and dynamics of the former, and the community structure and ecosystem processes of the latter.

C) Biological Diversity: the diversity of ecosystems, species and genetic variants within species. Boundaries between ecosystems are arbitrary to varying degrees; most kinds of ecosystems are defined by the dominant structure-forming species in their communities (e.g., redwood forests, sphagnum

bogs, coral reefs), by the set of physicochemical factors that makes them distinctive (e.g., serpentine outcroppings, vernal pools, exposed rocky intertidal zones), or combinations of the two. Maintaining the diversity of species is not simply maximizing the number in a given plot, but maintaining the number that naturally exists over an area having of a variety of community types, including species restricted to particular stages in the temporal succession of the communities. Since most species consist of more than one population, particular genes and genetically distinct populations of species are usually more localized than full species and ecosystems; as a result, the most frequent loss of biological diversity is the loss of the genetic diversity within species.

ACKNOWLEDGMENTS

This paper is based on the experiences and insights of members of grassroots conservation organizations, and on those with whom they have worked. They gave generously of their time, provided needed materials, and filled in an embarrassing gap in my understanding. To maintain confidentiality, I do not identify them, but I owe them my appreciation. Several have gained my deepest admiration for demonstrating exemplary courage, persistence and skill in voluntarily undertaking a Sisyphean task, one of the least appreciated and most difficult, yet also the most important among those confronting our species: saving life on Earth.

METHODS

I identified grassroots organizations, as defined in the INTRODUCTION, in Bryant and Gordon (1985). Most of them are listed in the section on State Citizen's Groups. The remainder are in the section on International, National and Interstate Organizations. Based on my experience with some of the groups,

conversations with scientists, government officials and environmentalists, my readings and the descriptions in Conservation Directory 1985, I chose 19 grassroots groups from the different geographic regions of the lower 48 states to represent a range of the following 6 structural and functional variables:

1. ORGANIZATION

These groups range in size, professionalism, permanence and affiliation from tiny, ad-hoc collections of amateurs that operate independent of any national organization to sizeable, long-established organizations staffed by professionals and affiliated with national organizations.

2. GEOGRAPHIC FOCUS

Grassroots groups range from those operating in a single locality to ones seeking conservation goals throughout an entire state or U.S. region.

3. PRIMARY ROLE

A) Educators. Many nongovernmental, nondiploma- or nondegree-granting groups provide information to the general public about local species and ecosystems. Some operate natural history museums, nature centers, or information clearing houses; others run camps for children; still others send visiting instructors and educational materials to schools, libraries and other places where groups of interested citizens are likely to be found. In contrast to advocacy groups, educational groups disseminate information to the public on a schedule relatively independent of pending actions by local, state or federal governments.

B) Advocates. Some organizations contribute to maintaining biological diversity primarily by serving as advocates for (or against) legislation, either as lobbyists working in state capitals or in Washington; as "grassroots lobbyists" aiming to mobilize nonmember citizens to influence the positions of their elected officials; as advocates for administrative rulemakings by executive agencies; or as litigants against governmental or private interests

they believe to be violating existing laws. Some advocates work to gain the attention of the public through the electronic and print media, with stories timed coincide with pending legislative actions.

C) Land holders and advisors. A substantial fraction of our terrestrial, freshwater, estuarine and marine intertidal biological diversity still occurs on private lands (subtidal lands are under state or federal jurisdiction). A number of organizations specialize in identifying lands that are priorities for conservation, for reasons including the importance of their species or ecosystems. They then employ a variety of means, including obtaining easements on or purchasing these lands. These organizations may manage the lands themselves or turn them over to other federal, state or private agencies for managing. Some organizations do not themselves purchase lands, but provide guidance on the many legal means (including purchase) to other institutions and individuals concerned about conserving the land's living resources.

D) Other. The main purpose of some groups is to encourage amateurs to study specific groups of organisms. A handful specialize in mobilizing hands-on conservation efforts, such as deepening pools in streams to improve trout habitat. Some serve primarily as information centers for other existing or newly-forming organizations. And a few, exemplified by the fictional protagonists in Edward Abbey's (1975) novel The Monkey Wrench Gang, act as conservation guerrillas, taking direct action against those whose destruction of species and ecosystems are required, encouraged, sanctioned, or at least not deterred, by law.

4. LEVEL OF FOCUS ON BIOLOGICAL DIVERSITY

Some groups focus on one species (e.g., the Trumpeter Swan Society), higher taxonomic grouping (e.g, Native Plant Society of Texas) or functional group (e.g., Upper Catskill Fur Takers) of species. Species-oriented groups

may focus on protecting rare species, which otherwise might be at risk of extinction, or on species that are not rare but have recreational, aesthetic or commerical value. Other groups (e.g, The Nature Conservancy) do not focus on any particular subgroupings of animals and plants, but specialize in conserving habitats of endangered species and distinct kinds of ecosystems in danger of disappearance. These endangered ecosystems often contain concentrations of endemic species (those which occur nowhere else).

5. PROPORTION OF FOCUS ON BIOLOGICAL DIVERSITY

While in-situ conservation of species or ecosystems is the explicit goal of some groups, other groups help to conserve species and ecosystems incidental to their primary focus, such as conservation of scenic values or watersheds.

6. EMPHASIS ON PRESERVATION VS. CONSUMPTIVE USE

Grassroots organizations occupy positions along the spectrum of emphasis on consumptive uses (hunting, trapping, timbering, fishing) of species and ecosystems through non-consumptive preservation.

7. FEDERAL, STATE AND CONSERVATION ORGANIZATIONS WITH WHICH THEY INTERACT

Grassroots groups interact with federal and state agencies, national and other grassroots groups, as official affiliates, as longstanding or ad hoc allies, or as opponents.

INTERVIEWING METHOD

I called the highest-ranking available staffperson or officer of each organization, and discussed the above variables in relation to the organization's interests and record of effectiveness in preserving biological diversity. I gathered information on the private organizations and government agencies with which the grassroots group interacts, and the constraints on its effectiveness. Whenever possible, to control for any bias inherent in self-evaluations, I called other individuals outside of, but familiar with the organizations to evaluate the staffmember's/officer's assessment.

RESULTS

Eighteen representatives and 11 independent reviewers of the 15 organizations provided information on their operations as defined in METHODS. The leaders of the following organizations were not available when I called and did not return my calls: Chesapeake Bay Foundation, Massachusetts Audubon Society, Chesapeake Bay Foundation, Florida Defenders of the Environment. The following summarizes my findings:

ADIRONDACK COUNCIL

Founded 1975; 3500 members, 3 paid staff

Covers Adirondack Park, the largest park in lower 48 states

Advocacy group which monitors state agencies, lobbies state legislature, some litigation; secondary educational emphasis

Ecosystem oriented

Focuses on "open space" (wilderness, forestry, agriculture), rather than biological diversity *per se*

Encourages both preservation and benign land uses; opposes development

Interacts with NY Adirondack Park Agency, NY Dept. of Environmental Conservation, National Audubon Society, Natural Resources Defense Council, Wilderness Society, National Parks and Conservation Association, and Adirondack Conservancy

CALIFORNIA NATIVE PLANT SOCIETY

Founded 1965; 7000 members, 2 paid staff

Covers California

Advocacy group which works primarily on federal, state and local legislation and rulemakings; advises, lobbies and litigates; strong secondary emphasis on education and research

Both species and ecosystem oriented

Focus entirely on diversity of native plant species and communities

Mainly preservation oriented, but encourages planting of wildflowers

Interacts with U.S. Fish and Wildlife Service, California Coastal Commission, Dept. of Parks and Recreation and Dept. of Forestry, and with International Union for the Conservation of Nature, Sierra Club and National Audubon Society

CAROLINA BIRD CLUB

Founded 1937, 1100 members, 1 paid staff

Covers North and South Carolina

Study group which encourages amateur birdwatching, conducts surveys, some education work; avoids advocacy

More species than ecosystem oriented

Focus entirely biological diversity, but not necessarily conservation *per se*

Preservation oriented

Interacts with The Nature Conservancy in NC

DESERT FISHES COUNCIL

Founded 1970; 400 members, 3 volunteer staff

Covers aquatic ecosystems in deserts of Southwest U.S and N.W. Mexico

Advocacy group that advises and provides information to federal and state agencies, sends position statements to legislators

Both species and ecosystem oriented

Focus entirely biological diversity

Preservation oriented

Interacts with U.S. Fish and Wildlife Service, Bureau of Reclamation, Bureau of Land Management, many state agencies, The Nature Conservancy

IDAHO TRAPPERS ASSOCIATION

Founded 1980; 350 members, no staff

Covers Idaho

Advocacy group that advises and lobbies on state level, also educates trappers

Species oriented

Focus entirely on biological diversity as exploitable resource

Consumptive use oriented

Interacts with U.S. Forest Service, Fish and Wildlife Service, Idaho Dept. of Fish and Game, National Trappers Association

IOwA CONSERVATION EDUCATION COUNCIL

Founded 1958; 700 members, no staff

Covers Iowa

Education group that holds inexpensive weekend environmental education workshops for teachers

More ecosystem than species oriented

Focus partly on biological diversity

Interacts with U.S. Soil Conservation Service, Iowa Dept. of Public Instruction, Iowa Association of Naturalists

LOUISIANA WILDLIFE FEDERATION

Founded in the 1940s; >7000 members; 2 staff

Covers Louisiana

Advocacy umbrella group of numerous local (mainly hunting and fishing) clubs, which advises and lobbies state, does litigation; some education

Both species and ecosystem oriented

Focus largely on biological diversity

More consumptive use than preservation oriented

Interacts with U.S. Fish and Wildlife Service, Forest Service, LA Fish and Wildlife Dept., National Wildlife Federation Hqs., Sierra Club, Save the Achafalaya Basin

MAINE COAST HERITAGE TRUST

Founded 1970; nonmembership organization with 5 staff

Covers coastal Maine

Land holders and advisors, working to obtain conservaion easements

Ecosystem oriented

Focuses on conserving scenic values more than than biological diversity

Preservation oriented

Interacts with U.S. National Park Service, Fish and Wildlife Service, The Nature Conservancy

MISSOURI PRAIRIE FOUNDATION

Founded 1966, 550 members, no staff

Covers Missouri prairies

Land holders and advisors, purchasing land and obtaining conservation easements

Ecosystem oriented

Focus largely on biological diversity

Preservation oriented

Interacts with MO Dept. of Conservation and Dept. of Natural Resources

ROCKY MOUNTAIN BIGHORN SOCIETY (COLORADO ORDER)

Founded 1975; 900 members, no staff

Covers Colorado mountains

Advocacy group that advises and lobbies at state level, supports and opposes various uses of federal lands; also funds bighorn research

Species oriented

Focus exclusively biological diversity; bighorn sheep

More consumptive use than preservation oriented

Interacts with U.S. Bureau of Land Management, Forest Service, CO Div. of Wildlife, Foundation for North American Wild Sheep

TENNESSEE CITIZENS FOR WILDERNESS PLANNING

Founded 1966; 400 members, 1 paid staff

Covers Tennessee and part of Kentucky

Advocacy group that lobbies and litigates at federal level; assists state agencies involved with land management

Ecosystem oriented

Focus somewhat on biological diversity

Preservation oriented

Interacts with U.S. National Park Service, Army Corps of Engineers, Tennessee Valley Authority, Environmental Defense Fund, American Rivers Conservation Council, National Parks and Conservation Association, Wilderness Society, Environmental Policy Institute

THE NATURE CONSERVANCY MARYLAND CHAPTER

Founded 1977, 8000 members, 4 paid staff

Covers Maryland

Land holding and advising group

Both species and ecosystem oriented

Focus entirely on biological diversity

Preservation oriented

Interacts with MD Dept. of Natural Resources, few federal agency contacts (other TNC state chapters in western states have much more), TNC headquarters

TROUT UNLIMITED NEW MEXICO CHAPTER

60 members, no staff

Covers New Mexico mountains

Advocacy group that advised, lobbied and litigated and state and federal level; did hands-on conservation work; now inactive

Species oriented

Focus somewhat on biological diversity; trout

More consumptive use than preservation oriented

Interacted with U.S. Bureau of Reclamation, NM Game and Fish Dept., national Wildlife Federation, Federation of Fly Fishers

WEST VIRGINIA HIGHLANDS CONSERVANCY

Founded 1967; 775 individual and 25 institutional members; 2 staff

Covers West Virginia

Advocacy group that lobbies and litigates at state and federal level; strong secondary emphasis on education

Ecosystem oriented

Focus largely on biological diversity

Preservation oriented

Interacts with U.S. Office of Surface Mining, Fish and wildlife Service, Forest Service, several state agencies, Environmental Policy Institute, Izaak Walton League

WILDLIFE EDUCATION PROGRAM FOR A LIVING FUTURE

One-person organization

Covers northern Minnesota and Wyoming

Educator; traveling exhibitor and speaker to school and civic groups

Species oriented

Focus entirely on biological diversity; preservation of gray wolf

Preservation oriented

Interacts with U.S. Fish and Wildlife Service, MN Dept. of Natural Resources, North American Wildlife Park Foundation, Defenders of Wildlife

DISCUSSION

Grassroots organizations do not merely duplicate or supplement the activities of government agencies and national conservation organizations; they can accomplish certain goals that governments and national conservation

organizations cannot, because they have somewhat different strengths. They also have characteristic weaknesses. Although they are an integral component of efforts to preserve biological diversity, they cannot replace the efforts of governments and national conservation organizations. Rather, our nation's successes in preserving biological diversity have resulted from the interaction of grassroots organizations with these other institutions.

DETERMINANTS OF SUCCESS--GENERAL

Most U.S. government and private organizations seeking to preserve biological diversity share one important advantage, and all share one enormous disadvantage. Although there is variation among regions, ethnic, educational and income groups, Americans as a whole have positive attitudes about animals and nature (Kellert, 1980). Polls have repeatedly shown that Americans favor environmental protection even at the sacrifice of some economic progress, a tendency that has remained as the electorate has grown more conservative. Unfortunately, biological diversity differs from, say, clean air. After polluters stop polluting, physicochemical and biological processes remove pollutants from the air. If no species become extinct, to varying degrees, ecosystems may recover from damage once reversible stresses on them are relaxed. But if genes are lost or species are driven to extinction, they cannot be resurrected. Thus, the fight to preserve biological diversity is inherently asymmetric. Preservationists need lose only one battle to lose the war; their opponents need win only one battle to defeat them, for, as McIntosh (1985) notes, their point is not to win, but to continue to play. Continuity can be precarious indeed: at one point, when its aquatic ecosystem became uninhabitable, an entire fish genus depended on Desert Fishes Council biologists, who resorted to keeping the last individuals in a horse trough!

There are marked differences between government agencies and private conservation organizations. Some factors that affect grassroots organizations

also affect national organizations; others are especially characteristic of the grassroots level. Ironically, some of the same factors diminish grassroots groups' effectiveness in conserving species and ecosystems. They include:
A) Ubiquitousness and Proximity. Like organizations that advocate conservation at the national level, some grassroots groups are instrumental in motivating legislatures to enact laws needed to conserve species and ecosystems, and in motivating executive agencies to carry out their legal mandates. Grassroots groups serve as monitors and gadflies of officials entrusted with serving the public interest. But, owing to limitations of resources, national groups can concentrate their efforts on only a fraction of issues that affect the whole nation and local issues of national significance. The sheer number of, say, Army Corps of Engineers actions with adverse environmental impacts assures that some will escape the attention of national organizations. But many did not escape the notice of the grassroots groups that I surveyed.

Their location near the resources they wish to conserve often makes grassroots groups the first entities to observe trends or articulate needs. Intimate familiarity with local resources raises the stakes for their individual members; it can be difficult to mobilize people who have never seen organisms or areas firsthand, and thus lack the grassroots activists' sense of ownership. And the proximity of grassroots conservationists to responsible state and locally-based federal officials has led to longstanding personal relationships. These contacts can be crucial. Officials beset from all sides when trying to reconcile the diverse wishes of citizens may resent the intrusion of "pressure groups" into what they come to regard as their sole responsibilities. But even officials who are not particularly sympathetic to conservation express respect and even appreciation for their activist neighbors who "keep us honest." Because many grassroots members are longtime local

residents, they can acquire extraordinarily useful knowledge about the practical aspects of the science, economics, laws and politics of conservation, and become unusually effective lobbyists. And this longevity confers another advantage: grassroots conservationists may ultimately win battles by outlasting unsympathetic elected, appointed or career officials.

Grassroots conservation education organizations can have close contact with the teachers in their states; indeed, many members are teachers. By understanding the needs, constraints and interests of schools and other local educational institutions, grassroots groups can provide specifically tailored materials and speakers with messages likely to be well-received.

Grassroots groups which obtain easements, purchase lands or provide counsel to other land conservationists often have longstanding relationships with potential donors. Expert knowledge of local history, sociology, property and tax laws, and the locations of especially valuable biological resources, and friendships with local officials facilitate this role. Often these groups learn about the availability of land "through the grapevine," before it becomes public knowledge.

I see no disadvantage to the localized focus of these organizations, except that in some regions they are either absent or, for various reasons, ineffectual. As a result, some endangered species and ecosystems would "fall through the cracks" without government agencies or national conservation organizations. And since the agencies and national organizations are mostly understaffed and resource-limited, species and ecosystems that do not receive attention from local organizations, all too often, do fall through the cracks.
B) Independence. Far more than government agencies, which get appropriations and accept direction from federal and state legislatures and executives, grassroots organizations are able to set their own agendas. Thus, they are freer to focus their efforts on their particular conservation priorities. Such

flexibility can be particularly valuable when quick action is needed to save ecosystems and species. For example, the Desert Fishes Council and The Nature Conservancy were instrumental in conserving the Ash Meadows freshwater ecosystems, with their extraordinary endemic biota, before responsible California, Nevada and federal agencies could work out ways to preserve them. One of the most important contributions of these organizations to conservation is their ability to act while state or federal officials are, in the words of one official, "getting their act together." In at least some cases, national conservation organizations, perhaps because their policymakers are more dispersed and they have more rigid hierarchical levels, are slower to respond to opportunities or crises than grassroots groups.

However, this freedom is not entirely beneficial for preserving biological diversity. Federal and state agencies involved in conserving biological diversity, to varying degrees, are mandated to allocate efforts to species as a function of endangerment, independent of their appeal to the public. To varying degrees, government agencies have taken this charge seriously. But neither grassroots nor national conservation organizations are under legal obligation to act in ways that would most enhance conservation of biological diversity. As their officials readily admit, organizations depending on public support are subject to market forces. If broadly-based conservation groups devote their efforts to organisms or areas with high recognition and appeal to the public, they will tend to gain in membership, donations, media attention and political clout. If they do not, they will not. Unfortunately, there is little correlation between the public appeal of a species or ecosystem and its priority in any rational system for allocating scarce conservation resources. As a result, some species get priority treatment whether or not they need or can benefit from it; others that are critically endangered will not. This is less a problem with narrowly-based groups having more knowledgeable members.

C) Organization and Constituency. Several other factors, which both increase and decrease effectiveness, are especially characteristic of grassroots organizations. Most of these organizations are much smaller than national conservation organizations, with memberships typically in the hundreds, not tens of thousands or more. Their members also tend to be ethnically, educationally, economically and politically more homogeneous. Because they live in a smaller geographic area, they have more homogeneous sources of information. Many do not have paid employees (or employ only clerical help) depending solely on the enthusiasm of volunteers. They often elect as leaders those individuals who are most active and skillful in advancing the group's agenda. Indeed, a large fraction of the members of these organizations know their leaders personally, and have ready access to them. All of these factors contribute to the vigor of many grassroots organizations, which contrasts sharply with the internal costraints and bureaucratic inertia that can plague government agencies and even national conservation organizations.

As a result of their characteristically small memberships, grassroots advocacy organizations seldom have the political clout that can be derived from the ability to make large campaign contributions. The broadly-based organizations usually lack the professionalism of the local, state and federal agencies interests whose activities they may oppose (although some groups, such as the Desert Fishes Council and the California Native Plants Society, may have more professional experts than the agencies and businesses involved in the same issues). Staffmembers of grassroots groups, if any, are usually paid very poorly. The lack of professional knowledge and credentials can greatly disadvantage these groups in hearings where they are pitted against better-paid professional "experts" working for government agencies or business interests. Untrained grassroots conservationists cannot readily prevail in toe-to-toe confrontations with professional attorneys, geologists or engineers. But the

"David and Goliath" contrasts that this produces, especially in the courtroom, can work in favor of the grassroots groups. In areas where sociopolitical populism is alive and well in the general population and the media, lack of professionalism can be a genuine advantage to conservation advocates. (After all, "amateur" does not mean incompetent; it means one who does something out of love, while professionals can be seen as mercenary or ignorant about the common man). And the intense motivation of grassroots conservationists can lead them to attain astonishing expertise without benefit of academic credentials. It is not surprising that many of the most successful leaders of national conservation organizations and other successful national leaders first honed their skills in grassroots organizations. Furthermore, disputes between grassroots organizations and opponents is seldom as unequal as would be predicted from comparing their respective war chests. Many grassroots advocacy groups are accomplished at securing pro bono publica assistance from attorneys and scientists, services for which their better-funded opponents must pay.

D) Affiliation and Networking. I chose some of the groups (Rocky Mountain Bighorn Society [Colorado Order], Idaho Trapper's Association, Louisiana Wildlife Federation, Trout Unlimited New Mexico Chapter, The Nature Conservancy Maryland Chapter) in part because they are officially affiliated with national organizations. But groups without official affiliation cooperate with national organizations to a surprising degree. The Wildlife Education Program for a Living Future works closely with the regional representative of Defenders of Wildlife. The Adirondack Council's governing board includes official representatives of National Audubon Society, Natural Resources Defense Council, National Parks and Conservation Association and Wilderness Society, and it works closely with the Adirondacks Conservancy, the local chapter of The Nature Conservancy, etc. The specifics of such mutualism vary; grassroots

organizations may lead, with consultation from the national partner, or vice versa. But the advantages are clear. Especially when federal agencies or national legislation are involved--a large fraction of the cases in my sample--ad hoc cooperative relationships are likely to arise. Grassroots groups probably identify the issues and initiate the relationships in most instances.

Conversely, the failure of the national organization to support its local affiliate can cause problems. Some years ago, the members of the New Mexico chapter sought the help of the national Trout Unlimited to stop the Bureau of Reclamation from permitting a power plant that the local chapter felt would ruin the trout fishery. Trout Unlimited declined to assist its affiliate, but National Wildlife Federation and the Federation of Fly Fishers did, and succeeded in stopping the dam. New Mexico Trout Unlimited members were so displeased that membership dropped from 400 to about 60. As a result, the New Mexico chapter is no longer active in conservation. The individuals who departed formed a new, more active group called New Mexico Trout.

There may also be tensions between national conservation organizations and their local affiliates that arise from differing political philosophies. Many of the National Wildlife Federation's state affiliates, composed mainly of hunters and fishermen, are much less interested in nongame species and ecosystem conservation than nonaffiliated NWF members and the staff of its national headquarters, leading to recurring disagreements about priorities. This internal division has at times lessened NWF's effectiveness. For example, it contributed to NWF's failure to join the coalition of national and grassroots conservation organizations working for reauthorization of the Endangered Species Act in 1982. This difference may have lessened recently. Despite such differences, the high frequency with which grassroots and national organizations work together reflects the substantial benefits of such relationships.

EFFECTIVENESS IN PRESERVING BIOLOGICAL DIVERSITY

To assess an institution's effectiveness in preserving biological diversity, we need a flexible yardstick that we can dispose of when our understanding increases, for there are important theoretical considerations underlying conservation strategies that have not yet received comprehensive treatment. For now, success should be measured in terms of preservation of sustainable examples of populations, species or ecosystems that maximally represent the full range of entities at that level. It seems obvious that, all things being equal (a notoriously rare situation in the real world), in a biogeographic region having a million hectares of protected ponderosa pine forest but only a thousand of protected coniferous rain forest, priority for additions should go to the latter. Yet the recognition of, and weight accorded to this simple principle varies markedly among the grassroots organizations I studied.

Among them, only The Nature Conservancy explicitly uses the term biological diversity in the statement of its objective. It is the obvious focus of some others. Representatives of still others said that it is a significant consideration in their activities. One or two had not heard of the term. Notwithstanding, the activities of all these organizations affect biological diversity, although their effectiveness in conserving subspecific genetic diversity, species diversity and ecosystem diversity varies enormously.

It is difficult to gauge effectiveness of educational organizations by the standards used for advocacy and land holding groups, in part because most of the benefits of education lie ahead. The Wildlife Education Program for a Living Future is a one-woman effort to bring increased understanding about wolves to local residents. By traveling to schools and other community centers with displays, slides shows and lectures, in programs targeted at adults as well as children, Ms. Berg has substantially softened the strong local

opposition to protection of wolves in Minnesota and Wyoming. Her message goes further, however, for she portrays these predators as important components of their ecosystems. The Iowa Conservation Education Council fills a little-appreciated niche by holding environmental education workshops for teachers. Of course, school children cannot vote, and working with them instead of legislators and agency officials may seem to be an unaffordable luxury when biological diversity is so threatened right now, but today's children could well be crucial for those species and ecosystems that survive until the next human generation.

The focus of the Carolina Bird Club is unique among the organizations I examined: it encourages bird study, a seemingly quaint avocation. But these life-listers play an important role in conservation: they inventory avian diversity in the Carolinas, permitting the states and The Nature Conservancy to set conservation priorities. They hosted an important meeting on conservation of seaside sparrows, several subspecies of which are endangered. And like many birders, they participate in the Audubon Society's biannual counts to monitor trends in avian diversity. Such efforts aid in conservation by making birds the best understood wild organisms, serving both as "miner's canaries" of biological diversity and as inspiration for much of the theory underlying the emerging science of conservation biology. Very important conservation-related scientific principles elaborated by ecologists, such as Robert MacArthur, John Terborgh, Jared Diamond and Thomas Lovejoy, arose from both their and amateur groups' observations of birds.

Three of the species oriented, consumptive use oriented advocacy groups differ markedly in effectiveness in conserving biological diversity. The contribution of the Idaho Trapper's Association is quite small. It fights vigorously for trapping seasons that coincide with times of the year when pelts

are most valuable. If consumptive use of organisms increases their ultimate chances of survival by creating a constituency for them, then this is a positive step. But this particular constituency is far more concerned with maximizing its return from trapping than the sustainability of the organisms its members seek, which makes the label "conservationists" seem inappropriate. They have not worked for closed seasons and habitat conservation measures that would increase biological diversity, unlike some other organizations interested primarily in consumptive use. If the Idaho Fish and Game Department is successful in keeping trappers' take within the limits of the furbearers to maintain their numbers, such activities probably have no large effect on biological diversity one way or another. The Association devotes most of its energy to improving the public image of trappers, but does its best to teach new trappers to avoid unintended capture of predatory birds, a task greatly complicated by the 50% annual turnover in its membership. It has helped the state to catch specific problem coyotes, rather than killing them wholesale. And it has very occasionally assisted state officials trying to live-trap problem grizzly bears or mountain lions for relocation.

Other consumptive users are more effective at conserving species and ecosystems. The Rocky Mountain Bighorn Society (Colorado Order) sees its subject as a beautiful part of nature, a magnificent object of the hunt, and an attractive source of revenue (some earmarked for bighorn research) where populations are harvestable. It fought to maintain a highly visible but non-huntable population near Denver, and opposed off-road vehicle use in lambing areas on public lands, which has broader conservation benefits. Colorado bighorn hunters contrast with Idaho trappers by being much wealthier, better educated, more sophisticated politically, better at public relations, more farsighted in their self interest and public interest, and more effective in sustaining their resource.

New Mexico trout fishermen, many of them former members of Trout Unlimited (now members of New Mexico Trout), are still more sophisticated. For example, a large fraction of the membership turned out for several weekends to help the underfunded Fish and Game Department build a stream diversion to restore native cutthroat trout to streams invaded by exotic brown and rainbow trout. They oppose actions that genetically swamp distinct trout populations. In cooperation with national groups having conservation goals that go beyond exploitation, they funded a lawsuit to oppose a federal proposal that would have diminished habitat for coldwater species. They support fishing techniques (e.g., barbless hooks) that allow return of trout where populations cannot withstand harvest pressures. These fishermen are effective conservationists.

The Louisiana Wildlife Federation is the leading advocate for biological diversity in a state that has lost much of its extraordinary wetlands. For example, it has worked with local, state and congressional leaders to protect the Atchafalaya Basin, the largest remaining backwater swamp in the U.S. It demonstrates that hunters and fishermen can be effective partners with preservationists in maintaining biological diversity.

The Desert Fishes Council is unique in my sample as a grassroots advocacy group interested resources that extend into another nation (Mexico). A large fraction of its members work as professional biologists in universities, state and federal agencies, and partly as a result, it has established a reputation so impressive that private and government decisionmakers are often the ones to initiate contact. The continued existence of much of the southwestern fish fauna in the face of increasingly severe threats (mostly due to withdrawal or other modification of the water in their habitats) is attributable largely to the Council's activities, from hands-on habitat improvement to effective work in statehouses and the U.S. Congress. In expertise, energy and experience, it ranks among the most effective conservation organizations in the country.

California Native Plant Society's focus on species and community diversity is similar to the Desert Fishes Council's. It has undertaken the enormous task of inventorying the rare plants of California (Smith and York, 1984), the state (after Hawaii) with the highest plant endemism. It won a legal action against a municipality intent on building a golf course that would have eliminated a thorn mint and a checkerspot butterfly species endemic to a single small serptentine outcropping. Its inventorying merited detailed treatment in The Nature Conservancy's (1982) study of on private organizations and preservation of natural areas. It is a model for plant conservation efforts nationwide.

Tennessee Citizens for Wilderness Planning, the West Virginia Highlands Conservancy and the Adirondack Council are very effective land-preservation oriented advocacy groups. Through years of lobbying and lawsuits, TCWP and WVHC have won campaigns to preserve large, biologically diverse areas in their states. AC monitors all developments that would threaten New York's Adirondack Park, an area 2.5 times larger than Yellowstone National Park. Biological diversity would not be declining so rapidly if there were more areas defended with comparable vigilance and dedication.

The Maine Coast Heritage Trust and the Missouri Priarie Foundation are land holding and advising groups. The former relies solely on conservation easements to protect scenic coastline; the latter also purchases prairie land whenever it becomes available. Their success in preserving biological diversity is not as great as some other groups because their actions are driven largely by availability or other criteria, not biotic uniqueness. Scenic shorelines are important esthetic resources, and certainly merit conservation, but such efforts benefit biological diversity less than those in which species and ecosystem preservation is an explicit focus. Still, although MPF eschews the scientific inventorying that forms the basis of The Nature Conservancy's operations as irrelevant to its efforts, it has benefitted species conservation

nonetheless. After purchase, one of its prairie plots was found to contain the largest remaining population of a rare milkweed species.

The uniquely systematic modus operandi and spectacular success of The Nature Conservancy's Maryland Chapter place it in a different class from the above two groups. TNC has established Heritage Programs in the governments of 35 states, including Maryland, which are computerized geographic inventories of community types and distributions of rare species. Using these, the Maryland Chapter develops a priority list of lands and seeks to purchase the highest priorities, encourage the state to purchase them, or secure a nonbinding agreement with private landowners that provides protection without transer of ownership. TNC headquarters provides the strategy, criteria and a small amount of funding; the Maryland Chapter chapter raises its operating and purchasing monies, identifies specific lands, secures them and manages them through an active system of volunteers. TNC is a very businesslike group, combining internal organization and rigorous management like that of the best for-profit corporations with the enthusiasm that is the greatest strength of grassroots operations. In combination with its sophisticated, carefully thought out scientific rationale, its balance between centralized national and decentralized state operations appears to be the keys to TNC's success. The Maryland Chapter has either acquired, achieved the protection of private owner registration for, or is in negotiation for 90% of its highest priority areas. It owns 16 reserves totalling some 10,000 acres of Maryland's biologically richest lands, and has transferred about the same amount to the state or other land managers. Among organizations working to conserve biological diversity, TNC is exceptional in its independence from other national groups, its scientific and managerial soundness, and in its record of preserving and managing more than two million acres of the most biologically diverse lands in the U.S.

CONSTRAINTS ON EFFECTIVENESS

Local opposition to land preservation (it lowers the tax base) constrains land holding groups in Maine and West Virginia; lack of environmental concern in some constituent sportsmen's clubs hampers the Louisiana Wildlife Federation. But by far the most frequently mentioned constraint on the effectiveness of grassroots groups is money. Even groups that are rich in dedicated volunteers who know what needs to be preserved and how best to do it will not save our disappearing biota if they lack the money for the essentials: lobbying expenses, court costs, office space, clerical help, equipment, postage, educational materials or the price of the land itself. A handful at most, particularly The Nature Conservancy, are brilliant fundraisers. Most barely get by. The Missouri Prairie Foundation struggles to maintain payments on 713 acres of prairie. The Desert Fishes Council is soliciting funds to help a Mexican conservation biology student to attend their annual meeting. Unfortunately, it is not easy to move a psyche to give money to sustain a Furbish lousewort. The conservationists who best understand the ecological requirements of a warbler, the legal intricacies of a state regulation or the political sensitivities of a key House member are not necessarily the best ones at penetrating that psyche and convincing it that saving a species is more rewarding than owning a videotape of "Dirty Harry." For want of protectors in the black, species and ecosystems are vanishing. Insufficient funding is the most important factor limiting the success of grassroots organizations in preserving biological diversity. Anything that serves to improve their financial soundness will benefit biological diversity.

Many determinants of the patterns of voluntary donation are beyond the control of Congress, but some are not. Grassroots leaders expressed deep concern over proposed changes to the tax laws that would lower or remove incentives for private citizens to give money, especially individuals who do

not itemize deductions. In an era when deficits unimaginable just a few years ago extend to the temporal horizon, decisionmakers must choose which among the nation's constituencies and programs will benefit and which will be harmed. Despite the combined efforts of governments, conservation organizations and the scientific community, genetic impoverishment, species extinctions and ecosystem destruction are continuing in our country. If preservation of America's biological diversity is to be a national priority, budgets for federal and state programs (e.g. the U.S. Fish and Wildlife Service's Office of Endangered Species) and tax laws that determine the economic health of private conservation efforts will have to be structured to reflect that priority.

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